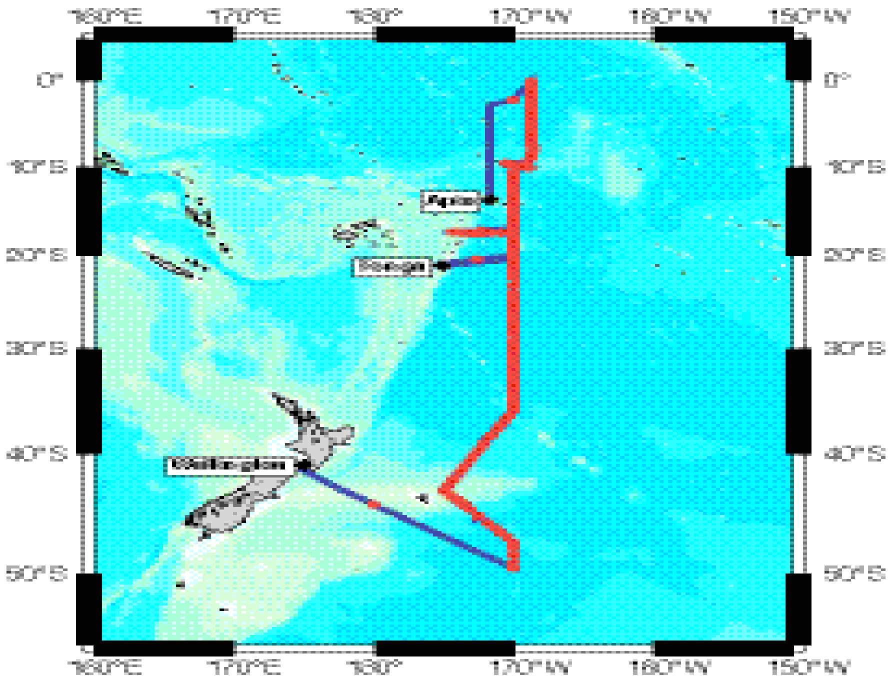
# CRUISE REPORT P15S
*(Updated AUG 2009)*




# A. HIGHLIGHTS

## A.1. CRUISE SUMMARY INFORMATION

| | |
|---:|---|
| Section designation | **P15S** |
| Expedition designation (ExpoCode) | **09FA20010524** |
| Chief Scientist | **Susan E. Wijffels / CSIRO** |
| Dates | 24 MAY 2001 - 8 JUL 2001 |
| Ship | *R/V Franklin* |
| Ports of call | Wellington, New Zealand<br>Nuku'alofa, Tonga<br>Apia, Western Samoa |
| Geographic boundaries | 0°<br>180° 170° W<br>49.5° S |
| Stations | 129 |
| Floats and drifters deployed | 0 |
| Moorings deployed or recovered | 0 |
| Chief Scientist Contact Info. | Susan E. Wijffels<br>CSIRO Marine Research - GPO 1538<br>Hobart, Tasmania 7000 Australia<br>Phone: 03 6232 5450 Fax: 03 6232 5123<br>e-mail: Susan.Wijffels@marine.csiro.au |

**LINKS TO TEXT LOCATIONS**

Shaded sections are not relevant to this cruise or were not available when this report was compiled

**Franklin Voyage Summary No. FR05/2001**

***Title***

Monitoring ocean climate change around Australia: the Deep-Ocean Time-Series Sections (DOTSS).

***Itinerary***

*Leg 1:*
Departed Wellington (New Zealand) 0915hrs Thursday 24 May 2001
Arrived Nuku'alofa (Tonga) 0830hrs Saturday 16 June 2001

*Leg 2:*
Departed Nuku'alofa (Tonga) 2200hrs Saturday 16 June 2001
Arrived Apia (Western Samoa) 1000hrs Saturday 7 July 2001 local (8 July 2001 AEST)

***Principal Investigators***

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Nathan Bindoff
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Mark Warner and Chris Sabine
University of Washington, Seattle, USA

John Bullister
NOAA-PMEL, Seattle, USA

***Scientific Objectives***

- Establish a time series of full-depth repeat ocean measurements capable of resolving decadal and longer time-scale changes in the structure and carbon storage of the oceans around Australia, from Antarctica to the equator.
- Use these data to test climate model predictions and to determine whether and how fast climate is changing due to the Greenhouse Effect and/or natural decadal variability.

***Cruise Track***

Starting in Wellington, Franklin steamed into deep water south of the Chatham Rise and a test station was completed. Franklin then steamed directly to 170° W, 50° S where the meridional survey began. From there, Franklin worked northwards and westwards to near Chatham Island crossing a deep western boundary current (see Figure 1). From there, the track was northeastward recrossing the boundary current back to 170° W, then along 170° W, until interrupted for an exchange of personnel in Tonga.

On Leg 2, near 17° S, the meridional line was interrupted in order to complete an additional crossing of the deep boundary currents found between 170° W and the Tonga-Kermadec Ridge. After completing this short zonal line, the 170° W meridional line was resumed until interrupted again near 10° S for a section across the deep Samoa Passage. From here the meridional line was completed to the equator along 168° 45'W.

***Results***

A total of 129 CTD casts were completed. Four of these were test casts of various types but the rest of the casts were mostly to within 15m (or more usually 10m) of the bottom. The casts were made along 3 sections (Figure 1): along roughly 170° W from 50° S to the equator (a partial repeat of WOCE section P15S), along 17.5° S from 170° W across the deep western boundary current east of the Tonga-Kermadec Ridge (a partial repeat of WOCE section P21) and across the Samoa Passage (a partial repeat of WOCE section P31) which is the main pathway of deep water from the South to the North Pacific Ocean.

On all casts a 24-bottle rosette system (10 litre bottles) was used to collect samples throughout the water column. Samples were collected for salinity, oxygen and nutrients (nitrate, phosphate and silicate) on all casts. On about half of the casts samples were also collected for dissolved inorganic carbon, alkalinity and CFCs (Freon 11, Freon 12) and on some casts carbon tetrachloride. The ship mounted acoustic Doppler current profiler, precision depth recorder and other underway instrumentation were run throughout the cruise.

At 6 stations, samples were also collected for John Lupton (NOAA-PMEL, Seattle, USA) for helium analysis.

The sections clearly show the major features expected — the northward penetration of Southern Ocean water masses (Sub-Antarctic Mode Water, Antarctic Intermediate Water, Circumpolar Deep Water and Antarctic Bottom Water) and the southward penetration of North Pacific water masses.

Initial analysis on board indicate the data are mostly of high quality. A post CTD calibration comparison indicates an rms difference between the bottle and CTD salinity of 0.0012 for bottles deeper than 1000 m (over 1300 comparisons). The bottle oxygen data also appears to be of high quality. Initial calibrations of the CTD oxygen sensor look promising with an rms difference between the bottle and CTD oxygen data of 5-6 μ mole/litre. However, even after the calibration, the times when the CTD oxygen sensor was changed can be seen, implying a need for further work on the calibrations. The nutrient profiles look promising but there is some station to station noise in the data and some apparent jumps in deep nutrients. Some of the later stations are being rerun because of growth in the auto-analyser sample line. The station to station noise and the apparent jumps should decrease after the samples have been rerun and corrections from the standard reference material have been applied.

On the last part of the first leg of the cruise and all of the second leg of the cruise, there was a contamination problem with the CFC samples, in particular with CFC-12. This was finally tracked down to the eucalyptus oil injected into the air-conditioning system. It appears that the oil settles on the Niskin bottles in the wet lab and then absorbs CFCs from the air before releasing it into the water samples. The CFC signals in the upper part of the water column and in the deep boundary currents are clear but the ability to determine CFC ages may be compromised (at least for depths of 1000 db to 4000 db). A full report on the CFC data collection and analysis in included as an Appendix.

The sections clearly show the major features expected – the northward penetration of Southern Ocean water masses (Sub-Antarctic Mode Water, Antarctic Intermediate Water, Circumpolar Deep Water and Antarctic Bottom Water) and the southward penetration of North Pacific water masses. In the deep zonal sections at 17.5°S and across the Samoan Passage, the northward flowing boundary currents are clear. At both sections, there has been an increase in CFC concentration since these sections were last occupied. However, no quantitative comparison with previous data has yet been undertaken.

Samples were analysed for dissolved inorganic carbon ($TCO_2$) and seawater alkalinity (TA). The TCO2 values were measured by coulometry using a SOMMA system. TA values were measured by potentiometric titration on a closed cell. For carbon parameters, full profiles (24 Niskin bottles) were taken every other CTD station along the cruise track, with surface and some fill-in samples (up to 14) collected at other CTD stations. Where possible, carbon analyses were made at stations that coincided with locations that had been analysed for carbon during WOCE on sections P15S, P15N, P21 and P6.

Data quality for both TCO2 and TA was monitored during the cruise using duplicate samples and by analysing Batch 52 Certified Reference Material (CRM) provided by Dr. Andrew G. Dickson, Scripps Institution of Oceanography. The data quality were good for both legs of the cruise. At each 24-bottle cast for carbon, three depths were sampled in duplicate. The duplicates were interspersed with the other samples from the cast and analysed. The measured CRM titration alkalinity values were used to calibrate the potentiometric titration cell volume. For 37 samples the calculated CRM alkalinity on both legs of the cruise the cruise was 2224.72 ± 1.03 mmoles/kg. Duplicate analyses for alkalinity showed an absolute difference between duplicates of 1.03 ± 0.91 mmol/kg (1 s.d.; n=150). $TCO_2$ results for CRM samples 2005.45 ± 0.83 mmol/kg (1 s.d.; n=66), and the absolute difference between duplicates was 1.08 ± 0.74 mmol/kg (1 s.d.; n=200).

Surface DIC values followed expected trends with gradually decreasing concentrations to the north, a minimum occurring at station 73, at ~17.5°S, before increasing again. The bottom water, below 5000 db, showed a very consistent value of 2257 +/- 2 umoles/kg until station 112, at ~8°S, when the concentration started to increase reaching values of 2277 umoles/kg at station 128, at the equator. A mid-depth maximum was very apparent on Leg II and increased in concentration as the track proceeded north.

Continuous measurements of the fugacity of carbon dioxide (fCO2) in surface waters were also made along the cruise track. The fCO2 measuring system is based on a "Weiss" type equilibrator and a LICOR 6252 Infrared Gas Analyser (IR). During a six hour cycle three CO2-in-air standards, clean outside air, and air equilibrated with surface waters are analysed. The three standards and the air sample are analysed for eight minutes each at the beginning of the six hour cycle. Measurements are made in surface waters for the remainder of the cycle. Data are recorded as one minute averages of readings taken every second. The CO2-in-air standards are referenced to the WMO molar scale and were prepared and calibrated by Dr. P. Steele, CSIRO Atmospheric Research, Melbourne. During leg 1, the underway seawater line does not appear to have been flushed sufficiently rapidly, resulting in warming of about 1° C between the seawater intake and equilibrator. The large warming and the low flushing rates through the water lines are likely to result in poor fCO2 data quality for leg 1. The flushing problem was corrected but not eliminated on leg 2, and the data quality for this leg is expected to have improved.

## *Cruise Narrative*

Leg 1

We left Wellington at 0915 on Thursday the 24th of May, 2001 and started heading South-East as soon as we were clear of the harbour. The first station, a bottle test station was done on the afternoon of the 25th of May at 44° 26'S, 179° 57'E. We then proceeded to the first station on the WOCE P15 section at 49° 30'S, 170° 00'W. We reached this station in the early afternoon of the 27th of May. We had had moderate following conditions all the way from Wellington. As we approached this station the weather obligingly swung around to the South, giving us moderate following conditions for the first part of the section.

When we reached the station at 45° 57'S it seemed that our luck with the weather had run out - the station had to be abandoned with the CTD at 4,000 metres due to rapidly worsening conditions. Once conditions improved we were able to start work again, having lost about 12 hours (29 and 30 May).

The weather then continued to moderate and we were once again able to make good progress until early on the 3rd of June, when we were at 39°S, 172°W. Conditions worsened rapidly, culminating in winds gusting above 60 knots. We only lost about a day here as, after about 12 hours, conditions started to moderate and we were able to begin work again in another 12 hours or so.

After that we continued to work in conditions varying between very light (winds less than 5 knots) and moderate (average winds in the low twenties, gusting to the high twenties) for several days. Mostly we had following conditions, enabling us to make good time between stations.

Late on the 12th the weather degenerated again, resulting in the loss of nearly half a day. Once we were able to start CTDs again we continued, completing the CTD at 20° 30'S late on the 14th of June before heading for Tonga.

We reached Tonga at 0830 on the 16th of June, having completed 66 CTD stations, two further along the section than had been planned. At three places along the section we had replaced two stations with one half-way between to help make up time lost for bad weather.

Leg 2

We departed Tonga at 10 PM Saturday June 16 and steamed east to recommence the 170°W CTD section. En-route we had a Muster, a safety briefing and a cruise briefing on Sunday June 17. We also did a test CTD station. After reaching 170°W, we continued the CTD section northward. At 17° 30'S, we completed a CTD section westward across the deep western boundary current near the Tonga-Kermadec Trench. Through much of this period, winds were light. After completing the section across the Tonga-Kermadec Trench, we steamed eastward to return to the 170°W section. By this time, the winds had increased to 25 kts from the southeast and the eastward steam was slow. We completed an additional trial CTD station, firing all bottles at 2500 m to do a blank test for CFC-12. We then continued the 170°W CTD section northward in decreasing winds, completed a section across the Samoan passage, and then continued the CTD section north along 168°W to the equator. Winds remained light to moderate for the rest of the cruise. A final test CTD station, firing all bottles at 2000 m, for a blank test for CFC-12 was completed. We then steamed to Samoa, docking at Apia at 1000 hours Saturday July 7, 2001. Enroute, the ship lost power on Wednesday July 4. Because the main UPS did not function, many of the instruments in the labs had to be restarted to complete the analyses of samples and the processing of data.

***Bottom Depth***

One unexpected feature observed on the PDR was a previously uncharted sea-mount at about 2° 3.36'S, 168° 45.098'W. The sea-mount rose from the ocean floor at about 5300 m to 1400 m over a distance of about 10 km. The bottom topography data bases derived from satellite altimeter data should be checked to see if this sea-mount has been previously identified. We moved the location of one of the CTD stations about 10 nm from above the steep slopes of the sea-mount.

***Summary***

There were many more samples collected than is usual for the small number of scientists that can be accommodated on board Franklin. As a result, the cruise was a heavy work load for all the scientific party on board. The available 12 berths limits the National Facility's capabilities. However, the cruise was successful. Virtually all of the stations were completed and an excellent data set collected. This data set should be a sound basis for detection of changes compared with previous observations.

***Problems and Recommendations***

The main UPS did not work for the whole of this cruise. As a result many of the instruments in the labs had to be restarted when the ship lost power on Wednesday July 4. Fortunately, this was after completion of all of the CTD stations but many of the analyses were still being undertaken. The UPS should be fixed as soon as possible.

There are a limited number of spares on board. We would have liked the ability to change the oxygen sensor but there were no further spares. Also there was no spare sounder display.

The University of Washington Niskin bottles were used throughout much of the cruise in an effort to minimise CFC contamination problems. While these bottles gave good salinity results, the valves and spigots were difficult to operate and there were numerous comments on the CTD log sheets about leaks from the end caps.

The bow thruster caused some problems as it can drop out when used at 100% power. This was not a major problem for this cruise, but could lead to losing more time to bad weather on a cruise where the weather was generally worse.

The Franklin should have a second MATLAB licence. This software is used extensively for user analysis functions, and is now also used heavily by ORV personnel for processing of data. The single licence leads to inefficiency in processing and analysing of cruise results.

On all of the deep CTD casts wire tension was very high. This necessitated hauling of the deep portion of casts at speeds as low as 20 m/minute to stay within recommended working tensions of the wire. Similarly, winch speeds were low at the start of the casts when lowering the CTD in moderate and rough weather. This is a result of not being able to put enough weight on the rosette package (so as not to load the wire excessively during the deep portion of the casts) to make it sink more rapidly. If winch speeds could be kept at 60 m/minute then the order of two days of ship time could have been saved. It is recommended that as soon as an opportunity arises that a thicker wire should be used. This would have the advantages of increasing the safety margin, saving ship time and increasing the payload thus expanding the National Facility's capability by allowing additional instrumentation to be placed on the CTD package.

***Personnel***

*Scientific participants on Leg 1*

| | | |
|---|---|---|
| Neil White | CMR | Cruise Leader |
| Ming Feng | CMR | Watch Leader |
| Don McKenzie | CMR | CTD |
| Lindsay Pender | CMR | Computing |
| Steve Thomas | CMR | Electronics |
| David Terhell | CMR | Hydrochemistry |
| Val Latham | CMR | Hydrochemistry |
| Neale Johnston | CMR | Hydrochemistry |
| Fred Menzia | University of Washington | CFC |
| Regina Cesario | University of Washington | CFC |
| George Anderson | University of Washington | Carbon |
| Mark Pretty | CMR | Carbon |

*Scientific participants on Leg 2*

| | | |
|---|---|---|
| John Church | CMR | Cruise Leader |
| Mark Rosenberg | ACRC | Watch Leader |
| Bob Beattie | CMR | Computing |
| Lindsay MacDonald | CMR | Electronics |
| Kautu Temaki | Kiribati Observer | CTD |
| Gary Critchley | CMR | Hydrochemistry |
| Kate Berry | CMR | Hydrochemistry |
| Neale Johnston | CMR | Hydrochemistry |
| Fred Menzia | University of Washington | CFC |
| Regina Cesario | University of Washington | CFC |
| George Anderson | University of Washington | Carbon |
| Jeanette O'Sullivan | CMR | Carbon |

***Acknowledgements***

We received excellent support from the Ship's officers and crew, the scientific staff and Franklin Operations officers. We thank them and the shore based support staff for ensuring the success of the cruise.

This cruise is a contribution to CSIRO's Climate Change Research Program, with partial funding provided by Australia's National Greenhouse Research Program. The CFC and US $CO_2$ programs were supported by funds from the National Science Foundation, award OCE-0095960.

Neil White,
Chief Scientist Leg 1,

John Church
Chief Scientist Leg 2

Original CSIRO Report can be found at: http://www.marine.csiro.au/marlin/rvdata1.htm

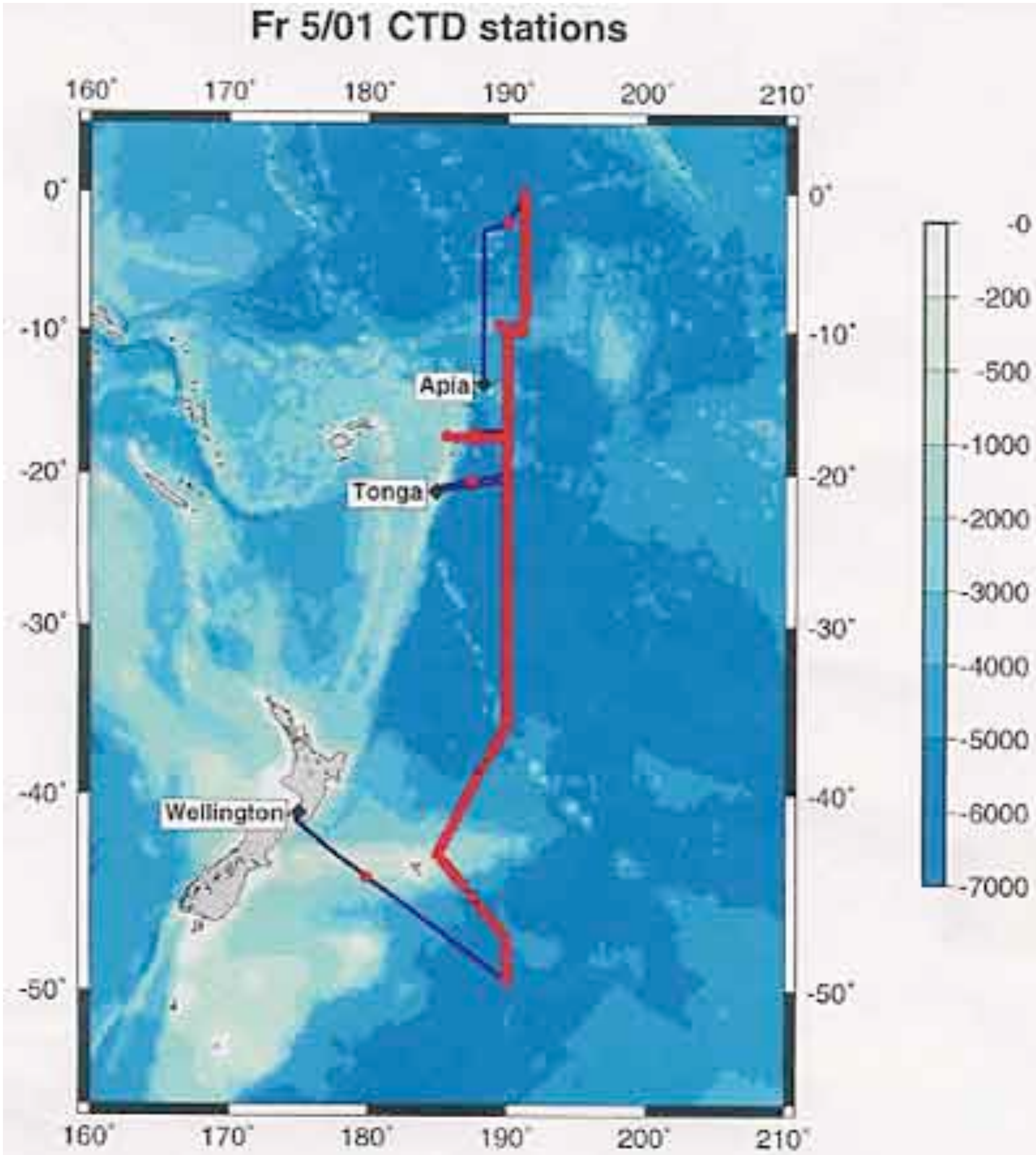


**Figure 1. Cruise Track from Wellington to Tonga to Apia, Samoa. The CTD station locations are indicated by the dots.**

# Underway Data

*Data processing completed by*
Bernadette Heaney, July 2001

## 1. Voyage details

"Monitoring ocean climate change around Australia"

### 1.1 Principal Investigators

Susan Wijffels, CSIRO Division of Marine Research John Church, Bronte Tilbrook and Steve Rintoul, Antarctic CRC and CSIRO Marine Reserach Nathan Bindoff, Antarctic CRC, University of Tasmania Mark Warner, University of Washing, Seattle, USA John Bullister and Chris Sabine, NOAA-PMEL, Seattle, USA

## 2. General underway data processing procedures

A set of standard "underway" instruments are logged onboard the research vessel "Franklin"; this data is displayed in real-time onboard to assist with voyage planning and watch keeping; some of the data is subsequently processed onshore to produce a set of standard underway data.

The data is logged to hourly files; the naming convention is explained in Section 7.1 on page 12; (these are referred to as "raw" data files.

The standard underway data set is 5 minute values of ship position (latitude and longitude), water depth, sea surface temperature and sea surface salinity; air temperature, wind speed and direction, humidity, barometric pressure, solar radiation; corrected wind speed and wind direction, ship direction and speed and gust.

All times in this report are UTC.

A data format guide can be found at http://www.marine.csiro.au/datacentre/process/formats/uwy.htm

## 3. Position

### 3.1 Instrument

Ashtech G12 sensor - installed on Franklin July 2000.

### 3.2 Raw Data

#### 3.2.1 *vvyydddmss*.gpoc files

5 byte records of integer values of:time in integer seconds since 1970 (nb whole seconds, ie per second)latitude and longitude in signed microdegreessigned u and v components of velocity in mm/s

#### 3.2.2 *vvyydddmss*.gpo files

A date and time string -gps date and time and system date and time at the start of each hourly file.

full resolution NMEA VTG and GGA strings (5 per each second)

### 3.3 Data Processing Procedures

#### 3.3.1 *.gpoc files

One minute position values have been decided using the *.gpoc files; these are loaded into the navigation archive and available in the "underway" data set

#### 3.3.2 *.gpo files

10 second position data has been extracted from the NMEA GGA string. This is available in netcdf format and was used for correcting positions in CTD processing - this data will be added to the "Data Warehouse".

### 3.4 Data Coverage

Start 23-May-2001 21:31
End 07-Jul-2001 14:17
Tonga - port call 15-jun-2001 15:36 - 16-Jun-2001 09:06

### 3.5 Data Quality

The accuracy of non-differential data from the G12 is sub 5 metres; differential correction can increase the accuracy to 1 metre.

From 22 June - 6 Jul there were unexplained gaps in the data of about 3-4 minutes occuring around 0700 utc daily. We are continuing to investigate whether this is caused by an incorrect instrument setting or a fault with the instrument. Similar gaps were also noted on leg 2 of FR 9/2000.

## 4. Water depth

### 4.1 Instrument

Continuously logged data from the Simrad EA 500 Scientific echo sounder.

### 4.2 Raw Data

#### 4.2.1 *vvyydddmss*.pdr

date and time (UTC)
data indicator
depth in metres (depth below surface )

#### 4.2.2 yyyymmdd-hhmmss.ek5

Sonar data echogram files.

### 4.3 Data Processing Procedures

Using *.pdr files, obviously bad depths are rejected. Depths are calculated for each whole minute by doing a linear regression through the data points within ±30 seconds of each minute and removing any outliers, then re-fitting until the standard error is acceptable.

 

### 4.4 Data Coverage

start 23-May-2001 21:49
End 07-Jul-2001 18:01

Tonga - port call 15-jun-2001 15:36 - 16-Jun-2001 09:00.The instrument was not working after the port call until 18-Jun-2001 09:50.

### 4.5 Data Quality

Standard error less than square root { (depth x .005) + 10 )}, ie less than 6.3 metres in water 6000 metres deep, or less than 3.2 metres in water 100 metres deep. The sound speed is set to 1500 m/s and no corrections are made for true sound speed.

The sounder incorrectly computed the bottom due to the maximum or minimum ranges being incorrectly set on several occasions so there is no data for these times (15-Jun-2001 03:58 07:40; 20-Jun-2001 05:21 - 06:50; 24-Jun-2001 09:43 - 10:11).

Because of increased bow thruster activity on stations 6, 9 and 10 the bottom could not be correctly determined and this data has been deleleted.

There was no echogram data for 5-Jul-2001 00:10 - 07:34 and 7-Jul-2001 03:46 - 18:01. So these data could not be verified against plots.

## 5. Sea surface temperature and salinity

### 5.1 Instrument

Seabird thermosalinograph

### 5.2 Raw data

One minute averages

date and time UTC

quality indicator mean temperature at the inlet mean temperature at the probe mean conductivity mean salinity turner fluorometer outputs (2) and spare channels (2) number of samples for the current minute

### 5.3 Data Processing Procedures

Surface values of sea temperature and salinity for each CTD station are compared with the thermosalinograph values. An offset is then applied to the sea surface temperature and salinity.

 

### 5.4 Data Coverage

**TABLE 1. Data rejected**

| Date | start time | end time | temperature salinity or both | comments |
|---|---|---|---|---|
| 23-May | 22:04 | 22:15 | b | |
| 29-May | 23:28 | 23:54 | b | |
| 02-Jun | 01:17 | 01:56 | b | |
| 04-Jun | 20:22 | 23:59 | b | instrument being repaired |
| 05-Jun | 00:00 | 23:35 | b | instrument being repaired |
| 17-Jun | 05:17 | 05:45 | b | |

### 5.5 Data Quality

There were many “spikes” in the salinity data up till the instrument was repaired.

The CTD salinity values should be within .003 resolution, and the CTD temperature within .003 degrees ; the thermosalinograph only records to the second decimal place so the best pre-cision would be within .01 psu for salinity and .01 degrees for temperature.

An offset offset was added to the salinity data of 0.004 and -.019 for temperature.

Fluorometer data is not a standard product.

Temperature and salinity data for this voyage compares well with CTD temperature and salinity data.

## 6. Meteorology data

### 6.1 Instruments

The **vvyynnnhmm**.met files contain values from the following selected instruments, as shown in the .metcal files. The meterorological station is mounted 17 m above sea level.

**TABLE 2. vvyynnnhmm.met**

**Instrument name**

| | |
|---|---|
| AD590 solid state temperature | air temperature |
| Vaisala solid state probe | humidity |
| 3 cup anemometer | wind speed |
| vane driving a potentiometer | wind direction |
| licor LI-192SB | radiation |
| rain guage | cummulative rain |
| and values of | ship speed and heading(from the doppler log and gyro) corrected wind speed and wind direction<br>max wind speed and wind direction<br>max corrected wind speed and associated wind direction |

The Vaisala Digital Barometer is mounted 9 metres above sea level inside the bridge.

**TABLE 3. vvyynnnhmm.vdb**

| | |
|---|---|
| vaisala PA 11 A digital barometer | bartometric pressure and the 3 hourly trend |

 

## 6.2 Raw data

### 6.2.1 vvyydddhmm.metcal

calibration and channel option file for Franklin meteorological file

### 6.2.2 vvyydddhmm.met

date and time (UTC) T/F to indicate if ship speed and direction data were available 1 minute averages of values for each channel as selected in the metcal file (usually air temperature, humidity, wind speed, wind direction, licor)

1 minute psuedo channels (ship speed and heading, corrected windspeed and wind direction, maximum corrected wind speed and associated wind direction)

each channel and psuedo channel has a quality indicator

### 6.2.3 vvyydddhmm.vdb

Date and time UTC quality flag barometric pressure in mBar three hourly trend quality flags

## 6.3 Data Processing Procedures

Bad data is flagged; 5 minute averages are produced and stored in the met data archive.

## 6.4 Data Coverage

Start 23-May-2001 21:29
End 07-Jul-2001 18:21
Tonga - port call 15-jun-2001 15:36 - 16-Jun-2001 09:06

## 6.5 Processed data

A rise in air temperature noticed 09-Jun-2001 08:47 -09:24 when the vessel was on station and in light winds; this may be due to the superstructure heating and/or air from the smoke stack wafting over the sensor.

The processed data has been loaded into the meteorology data archive; and the resultant eleven columns available for each 5 minute value are

**TABLE 4. Processed Meteorlogical data**

| | |
|---|---|
| air temperature | uncorrected wind speed |
| uncorrected wind direction | humidity |
| barometric pressure | solar radiation |
| corrected wind speed | corrected wind direction |
| ship direction | ship speed |
| gust | |

# 7. Other

## 7.1 Hourly file naming convention

**eg fr01079a00.gpoc vvyynnnhmm.int**

where vv is vessel where fr - franklin yy - year ddd - day through year a - hour through day a- 00; b 01 ... x 23 mm - 00 minute at start of file - usually files are started every hour - but if logging is restarted minute of restart .int - instrument gpo - gps gpoc - compressed gps pdr - precision depth recorder met - meteorological data vdb - barometer tsg - thermosalinograph

## 7.2 Printed material

Printed materials created during the processing are available from the Data Centre (Terry Byrne).

 

# ADCP

*Data processing completed by*
Bernadette Heaney, September 2001

## 1. Voyage details

"Monitoring ocean climate change around Australia"

### 1.1 Principal Investigators

Susan Wijffels, CSIRO Division of Marine Research
John Church, Bronte Tilbrook and Steve Rintoul, Antarctic CRC and CSIRO Marine Research
Nathan Bindoff, Antarctic CRC, University of Tasmania
Mark Warner, University of Washing , Seattle, USA
John Bullister and Chris Sabine, NOAA-PMEL, Seattle, USA

## 2. Processing Notes

### 2.1 Features of this voyage

In good weather conditions the depth range of the ADCP was good (350 m at maximum speed, 03-Jul-2001 10:47). There was very little bottom track data.

### 2.2 Special processing for this voyage

3 minute *.adp files returned from the ship were processed to produce a set of data corrected with 3DF heading. As it had been reported that the 3DF-GPS was not logging at some times during the voyage and also some concern that the ADCP logging also "hung" the data was also processed using heading from the gyro compass.

The raw ping by ping ADCP data files (*.rawdp) were processed using the program, rawdp2adp which was run combining raw ADCP ping data with gyro compass heading to pro-duce 3 minute *.adp files which were then processed in the usual manner to produce the stand-ard processed data set. Reference layer averaging for the production of *.adp files was over bins 2 to 8.

A subsequent examination of 10 reported gaps showed that during 7 of these gaps there was no gyro corrercted ADCP data as well indicating that the ADCP logging had "hung" as well at these times - this will be investigated further.

### 2.3 Profiles produced

#### 2.3.1 3DF GPS heading used

Best available correction (bottom track preferred to direct GPS ship velocities, preferred to position-derived GPS velocities). No reference layer averaging in final integration:

fr0105_3df.any: 3095 20 minute profiles.

fr0105_3df_60.any: 1037 60 minute profiles.

Bottom track corrected, no reference layer averaging in final integration:

 

fr0105_3df.abt: 7 20 minute profilesNon-integrated profiles (3 minute ensembles):

e_f0105_3df.any: 20634 3 minute profiles. All possible ensembles with best available correction (bottom track preferred to direct GPS velocities, preferred to position-derived GPS velocities).

GPS corrected (direct GPS ship velocities preferred to position-derived GPS velocities) the following *agp files were integrated using reference layer averaging over bins 2 to 8, then mergedwith files which were integrated using no reference layer averaging.

fr0105_3df.agp: 3095 20 minute profiles.

fr0105_3df_60.agp: 1037 60 minute profiles.

### 2.3.2 Gyrocompass heading used

Best available correction (bottom track preferred to direct GPS ship velocities, preferred toposition-derived GPS velocities). No reference layer averaging in final integration:

fr0105.any: 3098 20 minute profiles.

fr0105_60.any: 1038 60 minute profiles.

Bottom track corrected, no reference layer averaging in final integration:fr0105.abt: 7 20 minute profiles

Non-integrated profiles (3 minute ensembles):e_f0105.any: 20630 3 minute profiles. All possible ensembles with best available correction(bottom track preferred to direct GPS velocities, preferred to position-derived GPS velocities).

GPS corrected (direct GPS ship velocities preferred to position-derived GPS velocities) the following *agp files were integrated using reference layer averaging over bins 2 to 8, then merged with files which were integrated using no reference layer averaging.

fr0105.agp: 3098 20 minute profiles.

fr0105_60.agp: 1038 60 minute profiles.

## 2.4 Data Rejections

### 2.4.1 Data files using 3DF GPS heading

Out of a total of 20668 three minute ensembles, 20637 made it through to the processed file stage, with 575399 total good bins.

Bin 1 rejections: 385

Number of bins rejected due solely to:

%Good < 20%: 291641
%Good < 50% where RLA was bad and no acceleration: 4471
%Good < 70% where RLA was bad and there was acceleration: 168
Vertical velocity > 0.40 m/s: 153
S.D. of error velocity > 0.15 m/s: 1161
Isolates : 0
Absolute velocity > 2 m/s: 0
dv/dz shear per metre in upper 200 m > 0.035 m/s: 0
dv/dz sites: 37

Number of bins rejected due to multiple tests: 159260

#### 2.4.2 Data files using gyro compass heading

Out of a total of 20665 three minute ensembles, 20636 made it through to the processed file stage, with 580305 total good bins.

Bin 1 rejections: 367

Number of bins rejected due solely to:

%Good < 20%: 284629
%Good < 50% where RLA was bad and no acceleration: 3653
%Good < 70% where RLA was bad and there was acceleration: 129
Vertical velocity > 0.40 m/s: 281
S.D. of error velocity > 0.15 m/s: 1119
Isolates: 0
Absolute velocity > 2 m/s: 0
dv/dz shear per metre in upper 200 m > 0.035 m/s: 0
dv/dz sites: 43

Number of bins rejected due to multiple tests: 161162

# 3. Calibration

ADCP water profile vectors (measured relative to the ship) are calibrated by being rotated through an angle alpha and multiplied by scaling factor 1 + beta. The rotational calibration pri-marily corrects for misalignment of the transducer with respect to the ship, of the ship with respect to the gyrocompass (or 3DF GPS), and the error in the gyrocompass (or 3DF GPS). The scaling multiplier primarily corrects biases arising from the profiler itself. Both of these calibrations make a large difference to the resultant currents, particularly because they are both applied to the usually large ship-relative currents. For example, a scaling mulitplier of 0.01 applied when the water velocity with respect to the ship is 6 m/s alter the measured absolute currents by 6 cm/s.

The following calibrations were chosen for this voyage.

## 3.1 Files using the 3DF GPS ship's heading:

alpha = 0.987 +/- 0.3

1 + beta = 1.012 +/- 0.006

## 3.2 Files using the Gyrocompass ship's heading:

alpha = 0.957 +/- 0.3

1 + beta = 1.0099 +/- 0.006

 

# 4. Errors

The data provided should not be taken as absolutely true and accurate. There are many sources of error, some of which are very hard to quantify. Often the largest error is that of determining the ship's actual velocity.

## 4.1 Accuracy of water velocity relative to the ship

The theoretical approximate short-term velocity error for our 150 KHz narrow-band ADCP is

sigma =1/(pulse length X square root of pings per average)

For a 3 minute ensemble with say 170 pings, using 8 m pulse, this gives a theoretical error of 1 cm/s for each value (that is, independently for each bin).

For 20 minute profiles, with say 1150 pings averaged, the error in measuring the velocity of the water relative to the ship is probably reduced to the long term systematic bias. Of this bias, RDI says,

*"Internal bias is typically less than 1 cm/s, depending on several factors including tempera-ture, mean current speed, signal/noise ratio, beam geometry errors, etc. It is not yet possible to measure ADCP bias and to calibrate or remove it in post-processing."*

In addition, there are the transducer alignment and attitude sensor errors, which aminly cancel out where bottom-track ship velocities are used (Section 4.2 on page 8). For GPS ship velocity corrected currents, the transducer alignment and attitude sensor errors probably have a residual effect after calibrating of roughly:

0.3 cm/s per m/s of ship speed, due to, say, 0.3 degree uncertainty and variation in alignment angle.

0.6 cm/s per m/s of ship speed, due to, say, 0.006 uncertainty and variation in scaling factor.

This gives us, say, 0.67 cm/s error per m/s of ship speed, or <u>4.1 cm/s at 12 knots</u>.

Other sources of bias might be the real-time and post-processing data screening, and depth-dependent bias.

## 4.2 Bottom track profiles

Firstly note that errors in <u>current speed</u> arising from transducer alignment and attitude sensor limitations will substantially cancel out. Normally, the accuracy of screened bottom track data appears to be of the same accuracy as non-SA GPS, that is, about 2-3 cm/s for a 20 minute profile. However, the error in the <u>current direction</u> is at least the error in alpha.

# Hydrology Processing

*Data processing completed by*
Rebecca Cowley 8 November, 2001

## 1 Summary

These notes relate to the production of calibrated hydrology data for the *RV Franklin* voyage Fr05/2001.

Salinity, dissolved oxygen and nutrient data was processed. 128 deployments were completed, of which 128 have valid data.

## 2 Voyage details

The following information is taken from Voyage Summary Fr05/2001.

### 2.1 Chief scientist

Susan E. Wijffels (Chief Scientist)

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Tel: 03 6232 5450 Fax: 03 6232 5000
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John A. Church, Steve R. Rintoul, Bronte Tilbrook
CSIRO Marine Research

Nathan Bindoff
Antarctic Co-operative Research Center
University of Tasmania

Mark Warner and Chris Sabine
University of Washington, Seattle, USA

John Bullister
NOAA-PMEL, Seattle, USA

### 2.2 Voyage objectives

Establish a time series of full-depth repeat ocean measurements capable of resolving decadal and longer time-scale changes in the structure and carbon storage of the oceans around Australia, from Antarctica to the equator. Use these data to test climate model predictions and to,determine whether and how fast climate is changing due tothe Greenhouse Effect and/or natural decadal variability.

### 2.3 Area of operation

See Figure 1.

# 3 Processing notes

## 3.1 Introduction

The hydrology data was processed according to the procedures outlined in "Hydrology data processing procedures", First edition, Rebecca Cowley.

Hydrology data is collected on the upcast of a CTD deployment, and salinity data is compared to calibrated CTD upcast burst data. Erroneous values are deleted from the dataset. Dissolved oxygen and nutrient data are compared deployment to deployment, with obvious outliers deleted from the dataset.

CTD unit #20 was used on this voyage and 128 deployments were completed, of which 128 contain hydrology data. Salinity, dissolved oxygen and nutrient data were collected.

## 3.2 Salinity

Salinity data deleted from the dataset are shown in Table 1. All deletions were due to a bad sample or analysis. Many outliers were retained and can be attributed to the surface water structure which leads to anomolies between the CTD and hydrology data. The area of sampling had surface water with steep haloclines. The final CTD salinity – Hydro salinity offset plot is shown in Figure 2.

**Table 1: Salinity measurements deleted from hydrology dataset.**

| Deploy-ment | Rosette Position | Niskin bottle | CTD-Hydro salinity difference |
|---|---|---|---|
| 2 | 5 | 1107 | -0.015 |
| 2 | 11 | 1210 | 0.075 |
| 7 | 18 | 1261 | |
| 12 | 19 | 1231 | -0.009 |
| 12 | 22 | 1302 | 0.009 |
| 19 | 10 | 1266 | -0.014 |
| 25 | 21 | 1104 | -0.015 |
| 38 | 21 | 1104 | -0.011 |
| 47 | 6 | 1227 | -0.197 |
| 51 | 5 | 1107 | 0.073 |
| 53 | 21 | 1104 | -0.053 |
| 54 | 23 | 1114 | -0.014 |
| 60 | 22 | 1101 | 0.156 |
| 64 | 1 | 1233 | 0.036 |
| 64 | 13 | 1004 | 0.200 |
| 70 | 21 | 1204 | -0.020 |
| 71 | 21 | 1204 | -0.027 |
| 72 | 22 | 1231 | -0.015 |
| 73 | 9 | 1027 | -0.014 |
| 73 | 22 | 1266 | -0.012 |
| 74 | 21 | 1204 | -0.016 |
| 75 | 23 | 1114 | -0.024 |
| 78 | 20 | 1221 | -0.012 |
| 82 | 12 | 1217 | 0.013 |
| 85 | 18 | 1261 | 0.012 |
| 86 | 22 | 1266 | -0.017 |
| 87 | 21 | 1204 | -0.015 |
| 90 | 19 | 1215 | 0.013 |
| 93 | 17 | 1260 | -0.011 |
| 100 | 20 | 1114 | 0.011 |
| 115 | 19 | 1266 | -0.264 |
| 121 | 21 | 1037 | -0.023 |
| 124 | 16 | 1251 | -0.020 |
| 124 | 19 | 1266 | -0.111 |
| 125 | 9 | 1264 | -0.012 |
| 125 | 22 | 1010 | -0.012 |
| 126 | 24 | 1006 | -0.012 |

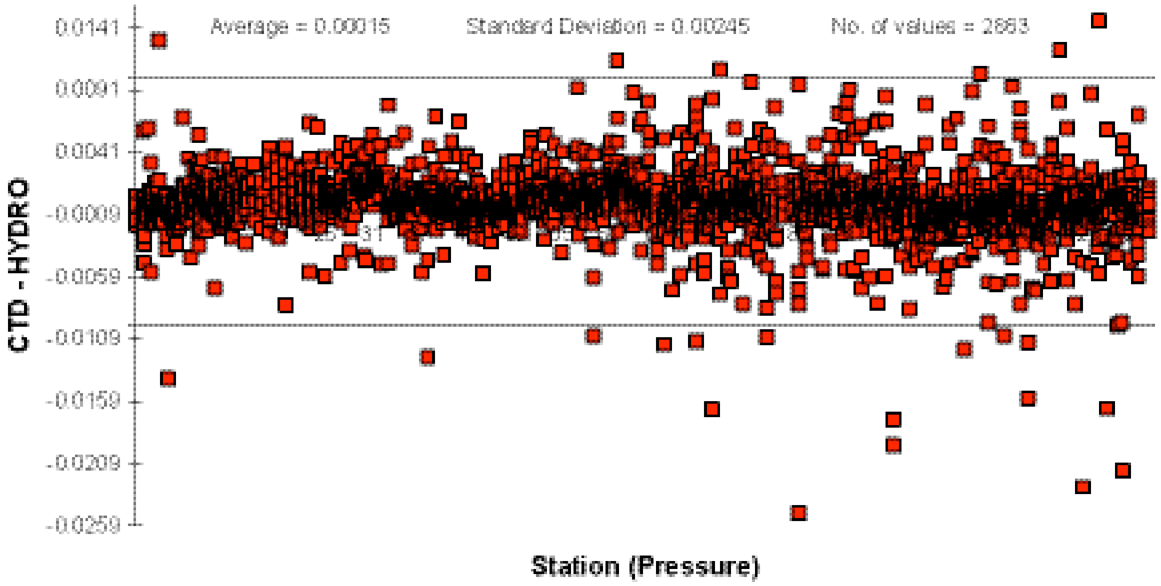



**Figure 2 CTD salinity – Hydro salinity final offset plot.**

### 3.2.1 Data Quality

Results in the first leg (deployments 1 to 65) have less scatter than the second leg. This may be due to several factors or a combination of them:

- Most of the scatter in figure 1 is in the top 200m of the deployments and may indicate a different water structure in the surface layers of the second leg compared to the first leg.
- Different analysts and samplers.
- Different climatic conditions.

## 3.3 Dissolved oxygen

Only one data point was deleted from the dataset (deployment 40, rosette position 11, bottle 1264), as the result appeared incorrect and was marked as a possible leaker in the CTD sheets. The corresponding nutrient and salinity results for this sample were not deleted as they appeared to be acceptable.

The results for station 40 were added to the dataset post-voyage and an edited oxygen file (f0105040a.scp) was saved with the original oxygen files.

### 3.3.1 Data Quality

The dissolved oxygen data quality for this voyage is good.

## 3.4 Nutrients

All nutrient results were retained.

### 3.4.1 Data Quality

Generally, the data appears to be of good quality, however there is no quality control report available for this voyage as yet.

# 4 Other

Niskin bottle numbers were altered from the 4-digit number to a three digit number for archiving purposes. The bottle numbers originally ranged from 1000 to 1400, and were a mixture of NOAA and CSIRO bottles. In the archive, the bottle numbers have had the first digit removed. Users are advised to refer to the CTD sheets to confirm the original numbers. Copies of the CTD sheets are available from Terry Byrne at the Data Centre.

Copies of printed materials and further information can be obtained from the Data Centre (Terry Byrne or Rebecca Cowley).

Processing completed by Rebecca Cowley on 8 November, 2001. Rebecca.Cowley@csiro.au

# CTD Processing

*Data processing completed by*
Bob Beattie, October 2001

## 1. Summary

These notes relate to the production of QC'ed, calibrated CTD data from R V Franklin voyage Fr 05/2001 (24th may - 7th July, 2001)

Data for 129 deployments was acquired using a Seabird SBE911 CTD unit fitted with a 24 bot-tle rosette sampler. Pressures and preliminary conductivity values were computed using the Seabird-supplied calibration factors and calibrations provided by the CSIRO Marine Research Calibration Facility were used to compute the water temperatures. The data was subjected to automated QC to remove spikes

The final conductivity calibration was based on a single, whole-of-voyage deployment, all sample depths, sample grouping. This calibration had standard deviation of 0.00216 p.s.u.

Dissolved Oxygen was calibrated by fitting the data to an Owens and Millard (1985) model of the Beckman-style oxygen sensor. It is apparent that this model does not quantify all factors affecting the sensor output, which means that the CTD oxygen values should only be used for qualitative interpretation.

## 2. Voyage details

### 2.1 Title

Monitoring Ocean Climate Change around Australia. The Deep Ocean Time-series Sections

### 2.2 Principal Investigators

Susan E Wijffels, CSIRO Marine Research, Hobart
John Church, Bronte Tilbrook and Steve Rintoul, Antarctic CRC and CSIRO Marine Research, Hobart
Nathan Bindoff, Antarctic CRC, University of Tasmania, Hobart,
Mark Warner & Chris Sabine, University of Washington, Seattle, USA

**CTD Processing Notes**

John Bullister, NOAA-PMEL, Seattle, USA

### 2.3 Voyage objectives

According to the voyage summary, these were to:

- Establish a time series of full-depth, repeat ocean measurements capable of resolving decadal and longer time-scale changes in the structure and carbon storage of the oceans around Australia, from Antarctica to the Equator.
- Use these data to test climate model predictions and to determine whether, and how fast cli-mate is changing due to the Greenhouse Effect and/or natural decadal variability.

For further details, refer to the Voyage Summary Report
(http://www.marine.csiro.au/franklin/plans/2001/fr0900s.html).

### 2.4 Area of operation

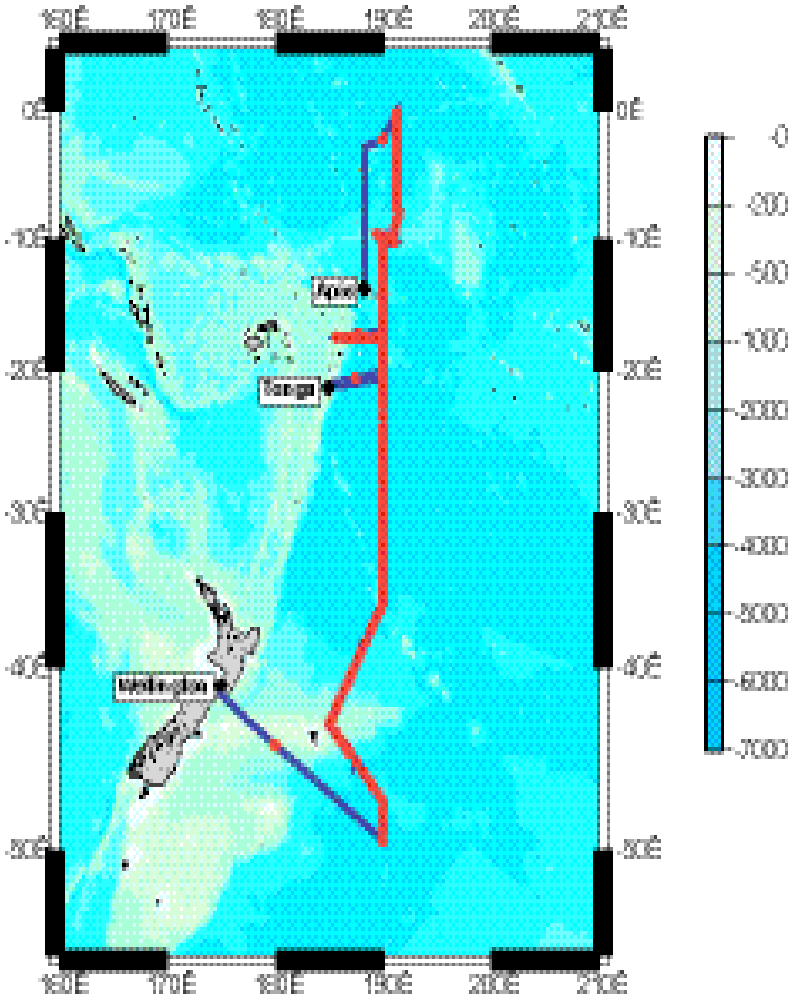



**Figure 1 Fr 5/01 CTD stations**

## 3. Processing Notes

### 3.1 Background Information

The data was acquired with CSIRO's CTD unit #20, a Seabird SBE911 with dual conductivity and temperature sensors, an SBE13B, 'Beckman' dissolved oxygen sensor and a 24-bottle rosette.

#### CTD Processing Notes

The raw CTD data was converted to scientific units and written to netCDF format files for processing using the matlab-based, procCTD package. procCTD is described in the procCTD User's Manual.

procCTD applies automated QC and preliminary processing to the data. This includes spike removal, identification of water entry and exit, conductivity sensor lag corrections and the determination of the pressure offsets. It also loads the hydrology data and computes the match-ing CTD sample burst data.

The bottle sample data was used to compute final conductivity and dissolved oxygen calibra-tions. These were applied to the data and the files of binned, averaged data were produced.

### 3.2 Pressure and temperature calibration

Pressures were computed using the Seabird-supplied calibrations. The temperature sensors were calibrated on 8th May 2001 at the CSIRO Marine Research Calibration Facility. (Calibra-tion reports 159T and 160T.)

An additional pressure offset correction was computed for each deployment by assuming a lin-ear drift between the pre and post-deployment, out-of-water pressures. The pressure offsets for the voyage are plotted in Figure 2, below. The pressure sensor shows slight hysteresis in its response, with the out-of-water offsets for the deeper deployments being about 0.4 dB greater than the in-water offsets.

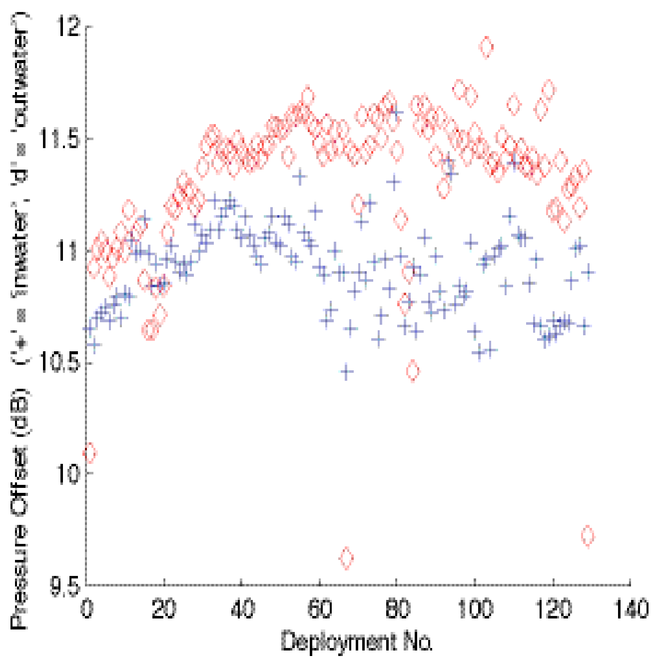



**Figure 2: Pressure Offsets, deployments 1-129**

The temperature sensors stayed in calibration during the voyage, as the mean outputs of the primary and secondary temperature sensors generally agree within +/- 0.2 mDeg C (Fig 3)

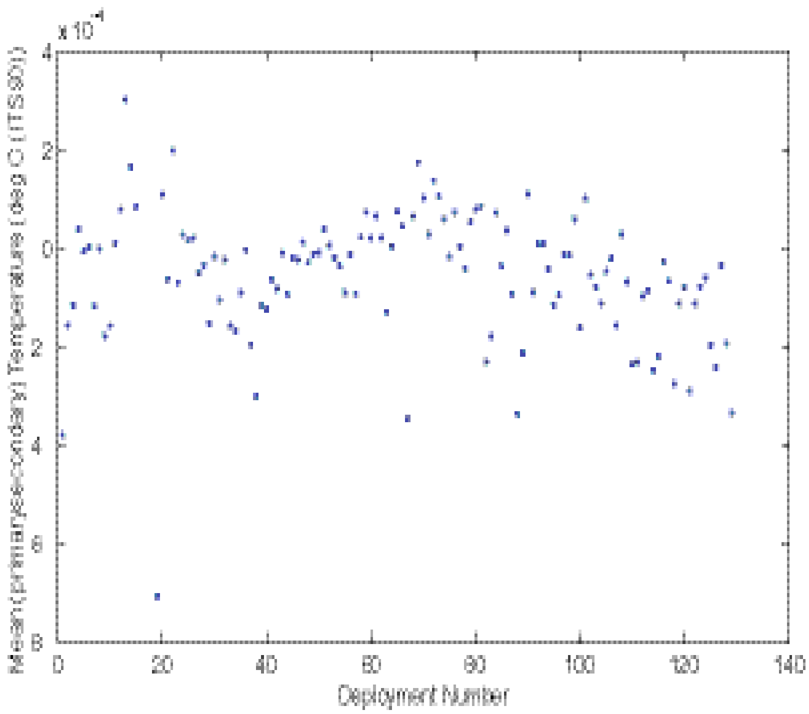



**Figure 3 Mean (Primary-Secondary) temperature, P >1000 dB**

### 3.3 Conductivity calibration

The procCTD conductivity calibration procedures differs from our old (pre procCTD) procedures in that

The calibration is applied in addition to the base (Manufacturer's0 calibration, rather than being applied to the raw data.

No allowance is made for inter-deployment drift.

It was decided to produce a single calibration, based on the sample data for all the deploy-ments, rather than break up the voyage into two, or more deployment groups. I consider this to be justified, as

1. There is no obvious deployment grouping in the in the plot of calibrated (CTD - Bottle) conductivity Figure 4.

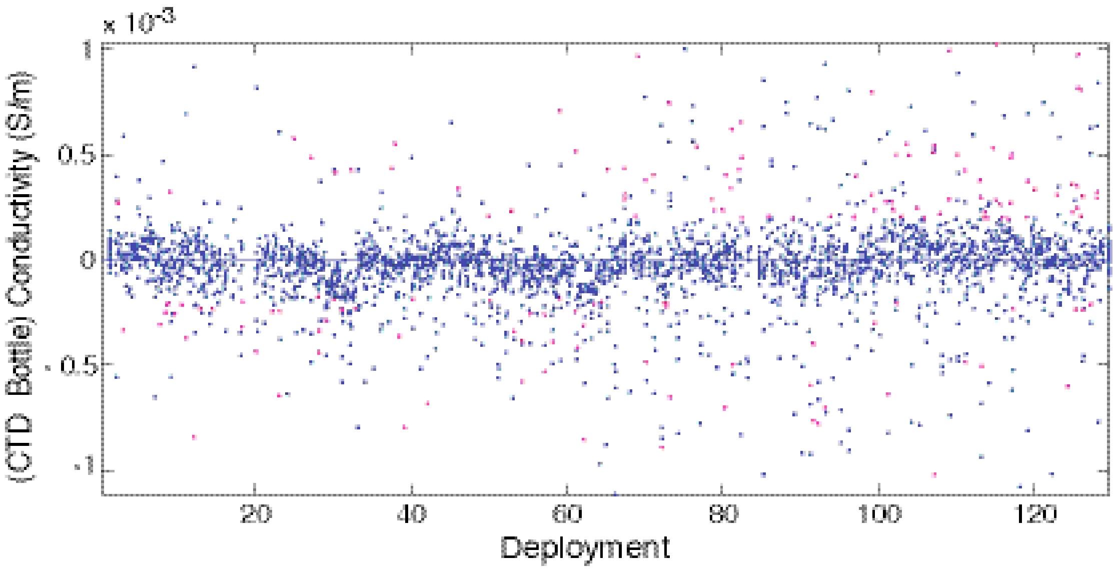



**Figure 4: Callibrated (CTD - Bottle) Conductivity**

Note:

There is a suggestion that there is slightly greater scatter in the data for deployment 67 onwards. This can also be seen if these deployment groups are calibrated separately. The pre-67 (Leg 1) deployments give a calibration fit standard deviation (SD) of 0.00179 psu and the post-67 (Leg 2) group an SD of 0.00245 psu. The cause of this effect is not known, but it is presumably due to a difference in the sampling or analytical procedures used on the two legs of the voyage

2. The plot of uncalibrated (Primary - Secondary) conductivity for pressures > 1000 dB (Figure 5) confirms that there were no major shifts in the calibration during the voyage.

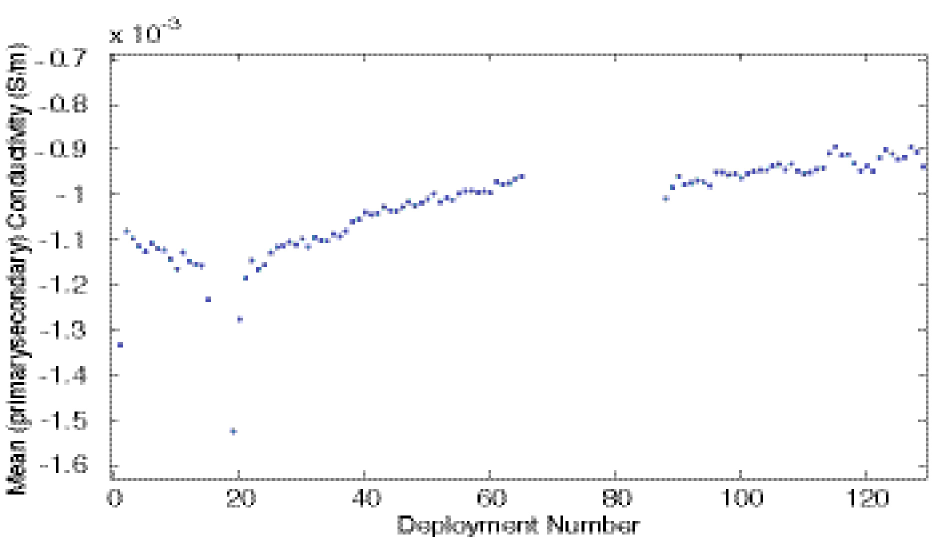



**Figure 5: Mean (Primary - Secondary) Conductivity, P > 1000 dB**

There was about 2.0E-04 S/m relative drift between the sensors, between deployments 20 and 64. The secondary cell failed during deployment 65 and was replaced before deploy-ment 88. The relative drift from deployment 88 onwards was 1.0E-04 S/m.

We have no way of telling which sensor was drifting, but no drifts of this magnitude are evi-dent for the primary sensor data (Figure 4). 2.0e-04 S/m translates to 0.0025 psu at 1.07 deg C, which is similar to the measurement precision that we are trying to achieve. This sug-gests that future versions of procCTD should include a drift component in the calibration.

The all-deployment data results in a calibration of

| | | |
|---|---|---|
| Scale Factor (a1) | 1.0003232 | w.r.t. M/facturer's calibration |
| Offset (a0) | -2.12262E-04 | ditto |
| Calibration S.D. (Sal) | 0.00216 psu | |

This is based on all the samples, apart from those excluded by procCTD's *Remove Outliers* option, and a small number of gross outliers that had been manually flagged as 'bad'.

The above calibration factors were applied to all deployments.

### 3.4 Dissolved Oxygen Sensor Calibration

#### 3.4.1 Data Quality

The oxygen data generally appears to be of good quality, but some problems were experienced, which resulted in the sensor being changed several times during the voyage (Thomas, 2001; MacDonald, 2001)

| Date | Deployment | Reported Problem | Action |
|---|---|---|---|
| | 1-33 | | Sensor S/N 130527 |
| 5 June | 34 | Steps in trace | Installed sensor S/N 130526 |
| | 67 | Steps in trace? | Swapped pump |
| 29 June | 109 | Steps in trace | Re-installed original sensor (130527) |

Note

It is likely that the steps in the oxygen were due to contact problems, as similar problems have been rectified in the past by screwing in the sensor to increase the contact pressure.

The following table lists deployments that appear to be affected by the above problems. It was compiled after a brief, visual inspection of the deeper, less rapidly varying segments of the oxygen profiles on the procCTD multi-parameter plots. No attempt has been made to correct or edit out the suspect data from the averaged files.

| Deployment | Problem |
|---|---|
| 26? | Small spike at 2500 dB |
| 28 | 'Steppy spikes', 2800 - 3000 dB |
| 29 | Bad step at 4500 dB |
| 30 | Bad step at 4000 dB |
| 31 | Bad step at 3500 dB |
| 33 | Small step at 3000 dB |
| 40, 41? | Possible, small steps vic. 2100-3600 dB (both) & 3700 (40) |

| Deployment | Problem |
|---|---|
| 66 | Many bad steps, esp 2300 -3300 & 4000 -5700 dB |
| 68 | Bad steps 4400 - 5400 dB |
| 77 | Small +ve spike at 4500 dB |
| 79 | Small -ve step, 4500 - 4700 dB |
| 104 | Small -ve spike, 4500 dB |
| 107 | Steppy profile 1400- 2100 dB(?), Small, +ve spikes 3400 - 3700 dB |
| 108 | Very steppy profile below 2000 dB |

The above list is not exhaustive.

### 3.4.2 Calibration procedure

Our model for the response of the Dissolved Oxygen sensor is based on Owens and Millard (1985). It uses an iterated, 6-parameter fit for the parameters:

Oxygen Current Slope (gain)
Oxygen Current Bias
Sensor Lag
Activation Energy
Reaction Volume
Temperature weight

In principle, the last 4 factors should be constant for the sensor type and geometry, with only the Slope and Bias changing, as the sensor becomes depleted. In practice, we iterate some or all of the other components, as we have not yet determined the ideal default values.

In addition, there seems to be a hysteresis effect that is not included in the sensor model. This means that it is not possible to produce a good fit of both the downcast and upcast sensor out-puts to the bottle data. (The 'downcast samples' are the downcast values for the same pressures as the 'Upcast sample bursts.)

The data from the two sensors used during the voyage was calibrated separately.

*Reaction Volume* and *Temperature Weight* were left at the default values of -29.6 and 0.9 resp.

***Deployments 1 - 33; 109 - 129 (Sensor s/n 130527)***

1. The iteration would not converge when I attempted to use all the deployments to compute the Sensor Lag and the Activation Energy, so these were computed using deployments 1-33 and were applied to both groups of deployments
   Sensor Lag 15.223
   Activation Energy 4692.4

2 The samples were calibrated against the downcast 'sample burst' data to determine the Slope and Bias.

| *Deployment grouping* | *Current Slope* | *Current Bias* | *Fit S.D. (uMole/l)* |
|---|---|---|---|
| 1 - 33 | 3.303E-04 | 8.1388E-04 | 3.7635 |
| 109 - 129 | 3.663E-04 | 1.0965E-02 | 6.5826 |

***Deployments 34 - 108 (Sensor s/n 130526)***

1. All the deployments were used to compute the Lag and Activation Energy
   Sensor Lag 40.145
   Activation Energy 4385.1

The lag is much higher than that for sensor 130527. I initially tried to use the value from this sensor, but this caused the down and upcast data to plot as separate populations.

2. The deployments were arbitrarily divided into 3 groups of sequential deployments, to reduce the effect of sensor depletion, and the bottle data were calibrated against the down-cast ‘sample bursts’ to compute the Slope and Bias.

| *Deployment grouping* | *Current Slope* | *Current Bias* | *Fit S.D. (uMole/l)* |
|---|---|---|---|
| 34-54 | 7.1586E-04 | -9.666E-03 | 7.834 |
| 55-74 | 6.9137E-04 | -1.1903E-02 | 6.318 |
| 75-108 | 7.0061E-04 | -1.0964E-02 | 8.481 |

### 3.4.3 Discussion

The sensor lags of 15.223 and 40.145 are higher than Seabird’s suggested normal values of around 7.0. Lindsay Pender (pers. comm.) thinks that, because we are not accounting for the hysteresis, it is being expressed in the lag.

There is a reasonable agreement between the bottle data and the downcast profiles, but it is by no means perfect. Figure 6 illustrates two typical examples

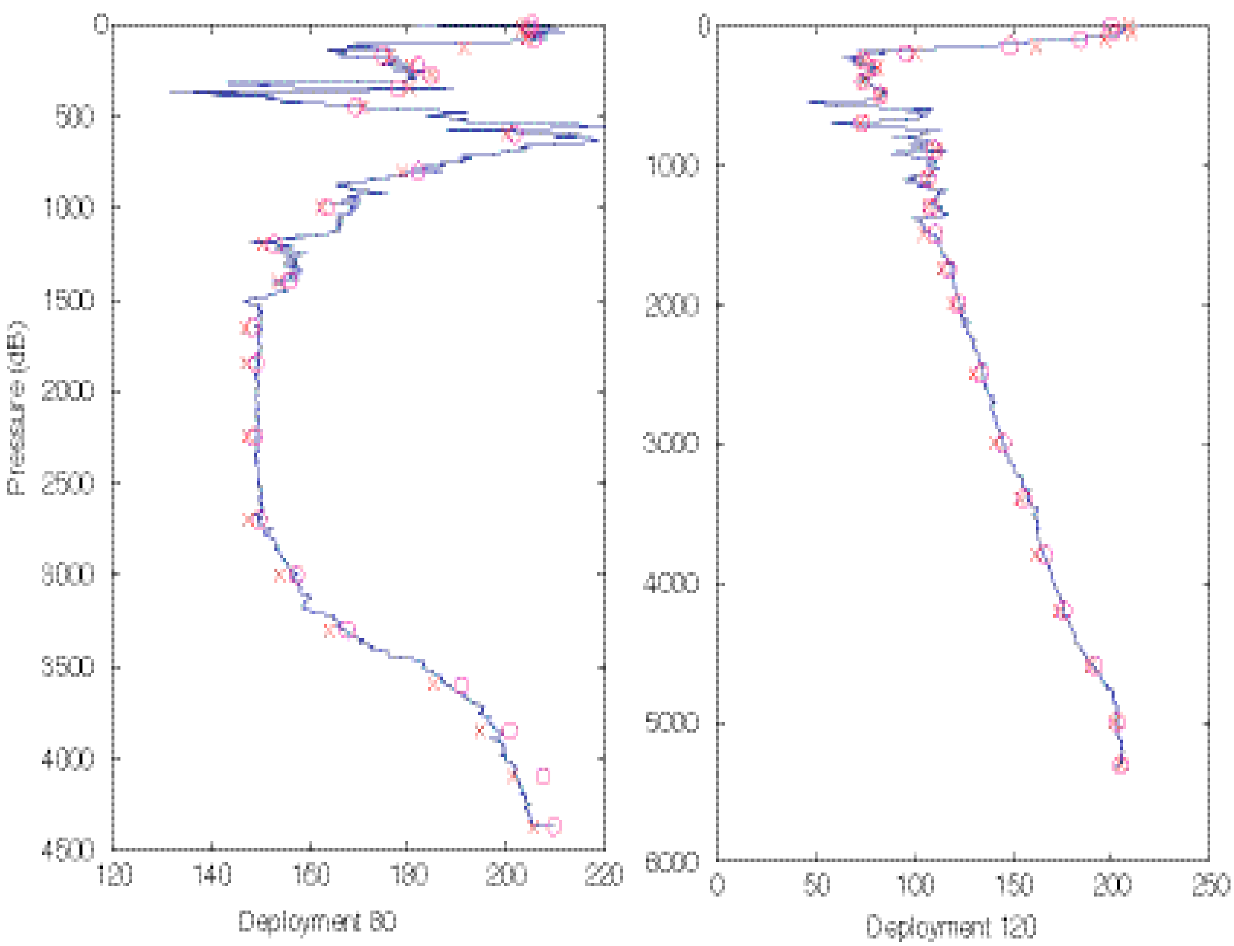



**Figure 6 Downcast CTD oxygen + bottle oxygen (o) & upcast CTD oxygen (x) (uMole/l)**

The calibrated oxygen data should only be used for qualitative and semi-quantitative work. It is as good a fit as can be expected, given the limitations of our current understanding of the oxygen sensor model.

### 3.5 Other sensors

No other CTD sensors were logged during this voyage.

### 3.6 Binned data files

The calibrated data was ‘filtered’ to remove pressure reversals and binned into 2dB averaged netCDF files. The binned values were calculated by applying a linear, least-squares fit to the bin data and using this to interpolate the value for the bin mid-point. This is more accurate than simply taking the mean of the data.

Each binned parameter in each bin is assigned a QC flag. Our flagging scheme is described in **http://www.marine.csiro.au/datacentre/ext_docs/DataQualityControlFlags.pdf**.

The QC Flag for each bin is estimated from the values for the bin components. (We haven’t yet documented this. For the moment, refer to the comments in matlab function matlab/toolbox/local/dpg/util/@QCFlag/estimate.m (or ‘help estimate’).) The QC Flag for derived quantities, such as Salinity and Dissolved Oxygen is taken to the worst of the estimates for the parameters from which they are derived.

## 4. References

Beattie, R.D., in prep, procCTD CTD Processing Procedures Manual. FrameMaker document /net/fdcs/opt/fdcs/src/ctd/doc/procCTD.fm

Owens, W.B, and J.C. Millard Jr., 1985: A new algorithm for CTD oxygen calibration. J. Phys-ical Oceanography., 15, 621-631.

MacDonald, L, 2001, Marine Instrumentation Voyage Report for R V Franklin Voyage Fr05B/2001, 16 June - 8 July, 2001 (unpub.).

Pender, L., 2000: Data Quality Control Flags. http://www.csiro.marine.au/datacentre/ext_docs/Data QualityControlFlags.pdf

Thomas, S., 2001, Marine Instrumentation Voyage Report for R V Franklin Voyage Fr05A/2001, 24 May - 16 June, 2001 (unpub.).

# Hydrochemistry, Leg 1

*(Val Latham, Neale Johnston and Dave Terhell)*

## Summary

The voyage principal investigator was Susan Wijffels

66 CTD stations were completed.

Analyses carried out:

| | |
|---|---|
| Nitrate/nitrite | 1467 |
| Phosphate | 1467 |
| Silicate | 1467 |
| Salinity (Guildline salinometer) | 1448 |
| Dissolved Oxygen (automated titration) | 1429 |


## Rosette and CTD

CTD #20 (new seabird) was used with the new 24 bottle .

## Niskin bottles

10L NOAA bottles.

## Salinity Offset

For those taking a preliminary look at the CTD data, the CTD was reading about 0.017psu low.

# Detailed Report (Hydrochemistry)

### ALPKEM

The Alpkem A/D box experienced problems on the first day Steve Thomas determined that the chip controlling data output to the computer was faulty. He modified this chip and the A/D box worked until the power was switched off to the unit when the same problem occurred. He replaced the chip with a different chip which was modified which is currently working.

The A/D box and the detectors have all been earthed as it was noted that touching any part of the Alpkem caused the baselines to shift.

The back pressure on the 3 channels was modified to optimise the system as was the wetting agent.

Towards the end of the cruise the Nitrate standard calibration started to fall below the origin and give low SRM recoveries. This is being checked.

**DISSOLVED OXYGEN**

The dissolved oxygen equipment worked well with no failures. A problem with the flasks is that some are getting chipped and have dangerously sharp edges which can be sanded blunt. Unfortunately there are not enough spare bottles to easily replace the chipped ones.

The data when compared to WOCE data showed an offset at depth due to different units. The units were corrected and the data was then in agreement. The correction was to multiply the oxygen units in micromol/litre by 1000/rho where rho is the potential density of the water sample (at zero pressure) using the full potential density (~1026 or so kg m-3) not just the density anomoly.

Oxy/kg = oxy/litre * 1000 / (potential density at zero pressure)

**SALINITY**

On startup the salinometer 62547 was found to have a blockage in the air tube above the 2nd bottom arm of the cell. This was cleared by pushing water, then air down the thick plastic tubing attached to the 4 air tubes. It was found that it was only necessary to use air.

The optimum settings for the lab airconditioner were found to be:

| Parameter | Setting |
|---|---|
| Mode | Heat |
| Temp | 22 degrees |
| Fan | High (showing fan icon with 3 sets of brackets) |
| Flap | Fixed straight out |

The above settings result in a Lab temperature approx 23 degrees..

# Hydrochemistry, Leg 2

*(Gary Critchley, Neale Johnston and Kate Berry)*

## Summary

The voyage principal investigator was Susan Wijffels

63 CTD stations were completed (129 for legs A plus B)

Analyses carried out :

| | Leg B | Leg A | Total in data set |
|---|---|---|---|
| Nitrate/nitrite | 1389 | 1467 | 2856 |
| Phosphate | 1389 | 1467 | 2856 |
| Silicate | 1389 | 1467 | 2856 |
| Salinity (Guildline salinometer) | 1437 + | 1448 | 2885 + |
| Dissolved Oxygen (automated titration) | 1387 + | 1429 | 2816 + |

## Rosette and CTD

CTD #20 (new seabird) was used with the new 24 bottle rosette.

## Niskin bottles

10L NOAA bottles.

## Salinity Offset

For those taking a preliminary look at the CTD data, the CTD was reading about 0.017psu low.

## Data

Some preliminary editing of salinity values, whilst not all necessarily wrong because of disagreement with CTD burst data, were removed in order to get a "cleaner" look at the comparative plots of sample versus CTD values. This was only completed up to station 108. Some dissolved oxygen data was edited, as necessary. Check data present indicates the data set is quite complete for stations 67 –129. Unfortunately, all the paperwork from Leg A was removed from the vessel at Tonga, which meant we were unable to verify the presence/absence/errors of data from leg A. There is also the chance that inadvertently, some leg B data was written over leg A data.

## Detailed Report (Hydrochemistry)

### ALPKEM

The Alpkem A/D box worked for the duration after being repaired on the first leg. The Phosphate detector became unstable during the cruise and was replaced by the spare. On being checked by lindsay no fault could be found. The spare Phosphate detector lost power to the Lamp which was discovered to have been caused by a leak shorting out the remote control board in the back of the detector. The original detector was put back into service and was stable for several days and then again became unstable. The repaired spare was put back into the system. Again no problem could be found with the unstable detector. Feeling is either it's breaking down when gets overheated or else there's a bad connection

The Nitrate standard calibration fell below the origin and gave low SRM recoveries. The problem was discovered to be a growth in the sample line, this was cleaned out and all the duplicate samples are being run. The two results will be compared back in Hobart and a final data set prepared.

There was very little drift in any channel. A cooling coil was placed into the Phosphate line which has stabilised the chemistry so there is no drift with lab temperature changes.

The cadmium is now stored under Nitrogen gas as it is thought that storage in the air in the lab deteriorated the cadmium. One of the lengths of Cadmium gave poor columns with a lot of trouble getting a regular bubble flow out of the 3 coils made from it.

On a whole the system is running very well.

## DISSOLVED OXYGEN

The dissolved oxygen system performed very well, with good quality data being achieved.

An incorrect determination of the bi-iodate normality was made (0.0091150N) and this was used for stations 76 – 92. The correct normality was determined as being (0.0100015N). The dissolved oxygen for these stations in the hydro program, micromoles per litre, were all multiplied by (0.0100015/0.0091150) to correct the effected oxygen data.

## SALINITY

Salinometer 62 021 was used for all of leg B, set at a bath temperature of 24, and was found to be extremely reliable and stable for the whole voyage.

Due to some overfilling of the bottles on some casts, it was quite difficult to obtain any consistent readings for some samples due to the inability to fully shake and mix the sample prior to analysis.

After preliminary calibration of the CTD using the analysed salinities, a standard deviation of 0.0027 psu was achieved for full water column data. Below 1000 metres, the standard deviation achieved was 0.0012 psu. The upper 1000 metres had a lot of structure and some very steep gradients.

The optimum settings for the lab air conditioner were found to be:

| Parameter | Setting |
|---|---|
| Mode | Heat |
| Temp | 21 degrees |
| Fan | High (showing fan icon with 3 sets of brackets) |
| Flap | Fixed straight out |

The above settings result in a Lab temperature approx 24 degrees, with the small desk fans on, to move the air around the salinometer work area.

## TO DO

Seawater lines on Port side sink and top fresh water tap on Starboard sink have very low pressure. Scheduled for next port period. (att ships working group)

Look at using stills for water production for Milli-Q system as seemsd to be some problems with feed water quality from vap system.

Look at using pinch valves rather than solenoid valves in the second system.

## SUPPLIES REQUIRED

Thermometers for DO samples.

Computers to replace the Octec computers.

# NUTRIENTS

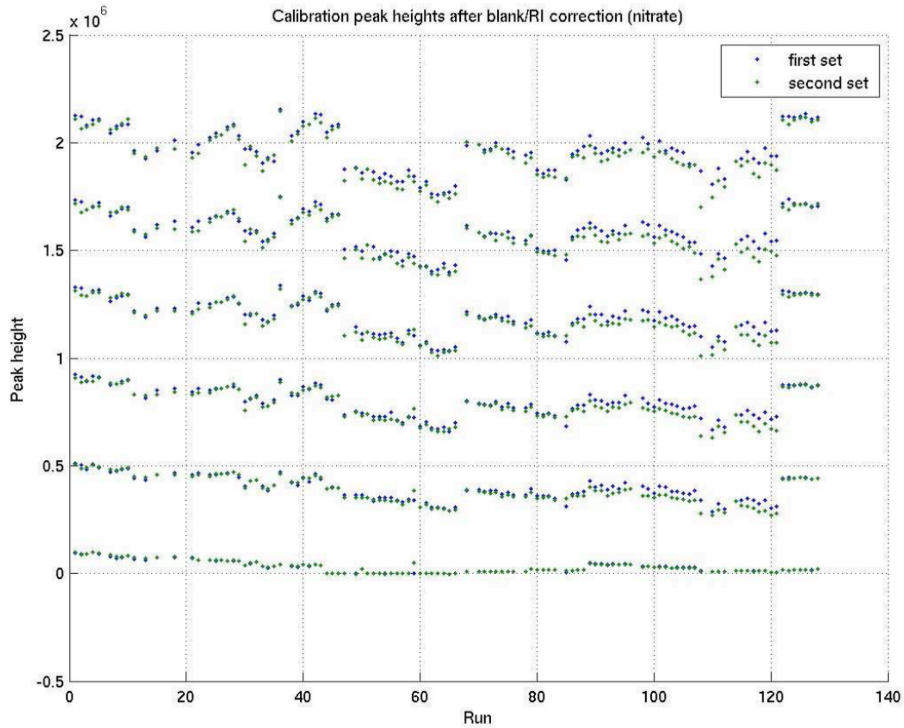
Rebecca Cowley, Susan Wijffels, December, 2008.
This is an abridged version of the original report which contains more detail on the correction methods investigated. For the full version, contact Rebecca.Cowley@csiro.au.

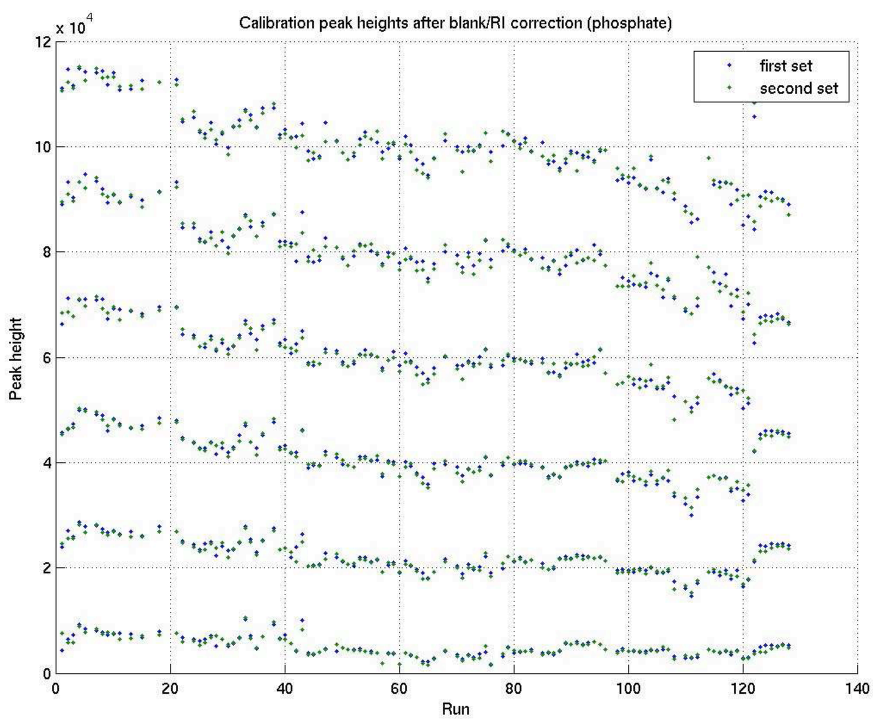
Introduction:
Data was collected in the Southern Pacific Ocean along P15S during 2001. The nutrient data from the voyage was known to have large errors associated with it, particularly with nitrate and phosphate. The data has been reviewed and re-processed, comparing it to the DISCO 1996 voyage along the same section. This report discusses the reprocessing method and results. All final results are reported in umol/kg. Nitrate concentrations refer to nitrate+nitrite.

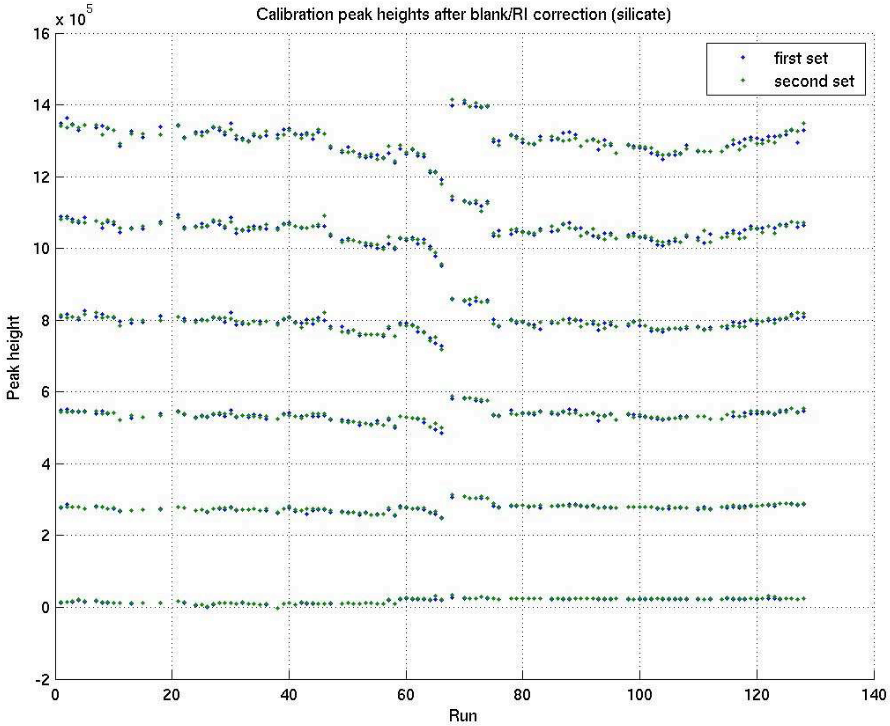
Procedure:
1. Re-calculate concentrations: From about run 40 to near the end of the voyage, it was clear there was an issue with the Alpkem in both the nitrate and phosphate channels. It was discovered at the end of the voyage that there was a growth in both flow cells. This resulted in depressed peak heights (see figures below – 'first set/second set' refers to the first and second set of calibrants in each run).

   The re-calibration method uses the f values for each level of calibrant, and the sample results were calculated based on the f values from the next-highest calibrant.

2. Final plots to flag outliers: The final results were plotted against ctd pressure and theta to identify outliers. The outliers were flagged as 'bad' (with a 4 according to WOCE standards). Any results where pressure was missing were flagged with a 4 and any where oxygen and salinity were missing were flagged with a 3 (questionable).


Calibration peak heights after blank/RI correction (nitrate)
x 10^6
first set
second set
Peak height
Run
2.5
2
1.5
1
0.5
0
-0.5
0
20
40
60
80
100
120
140

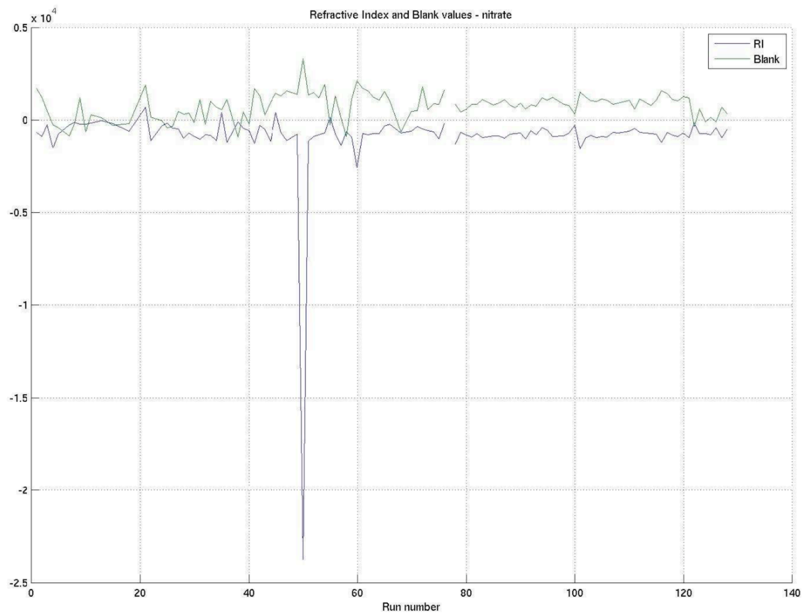

Calibration peak heights after blank/RI correction (phosphate)
x 10^4
first set
second set
Peak height
Run
12
10
8
6
4
2
0
0
20
40
60
80
100
120
140




# Corrections to Nitrate/nitrite data

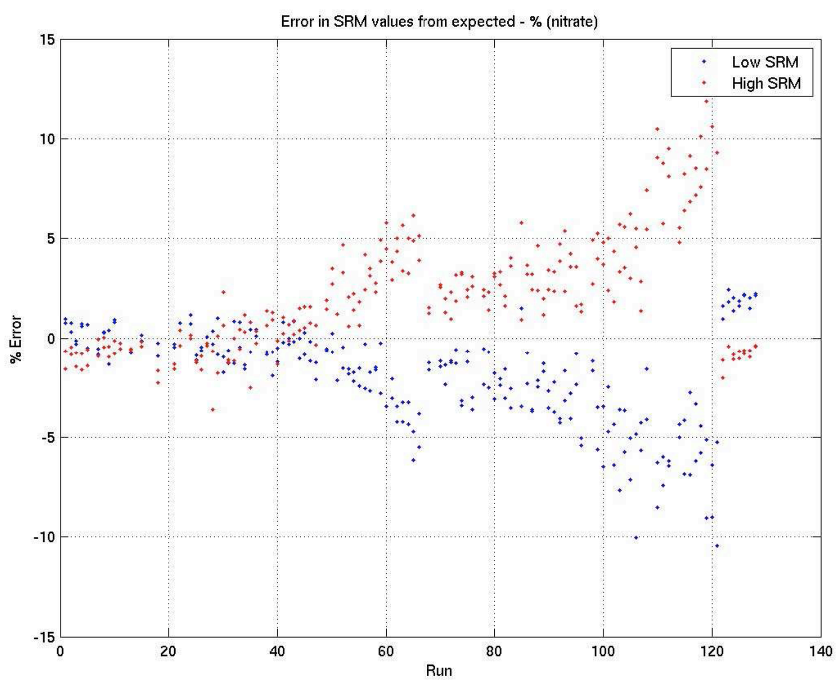
1. **Use an average refractive index and blank value.** In place of the actual refractive index and blank values for each run, an average value from all the runs was calculated and used in the peak height correction for each run. This made some improvement in the precision of the results between runs.

Refractive Index and blank values for each run.

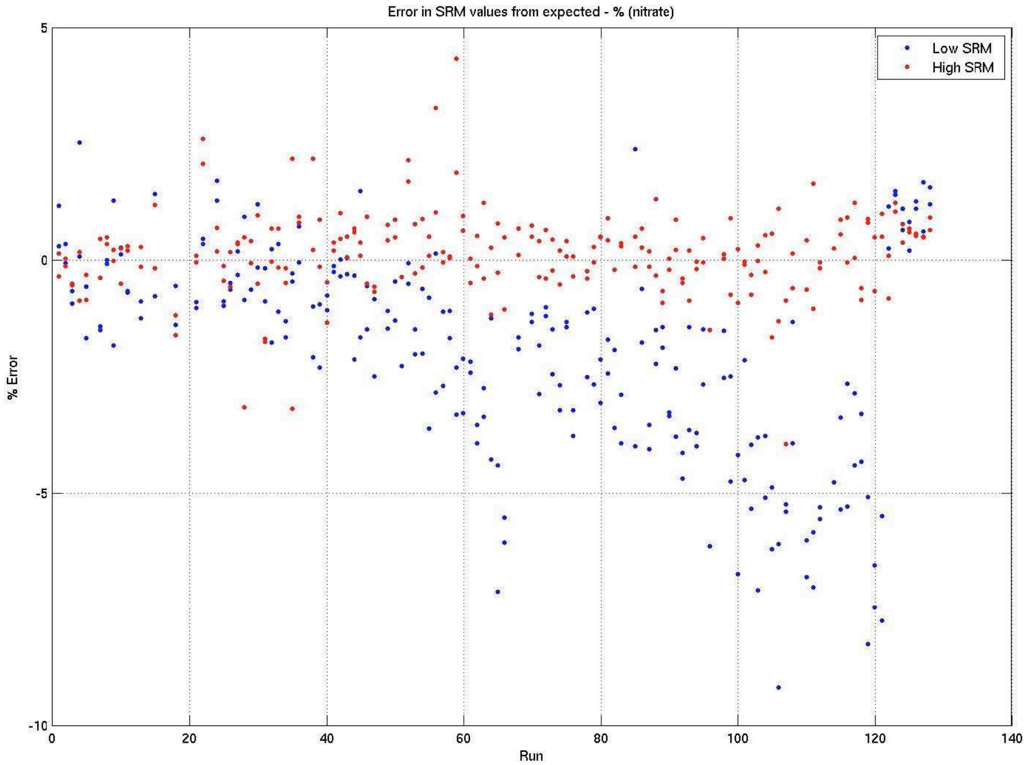



2. **Recalculation of data with sensitivity factors from the next highest calibrant.** Closer evaluation of the WOCE method (looking at actual OSU runs) showed that OSU only utilised one standard when calculating the sensitivity factors. This makes sense when the system is completely linear and the sample concentrations are close to the calibrant concentration used. For this data, the next highest calibrant from the sample concentration was used to calculate the concentration.

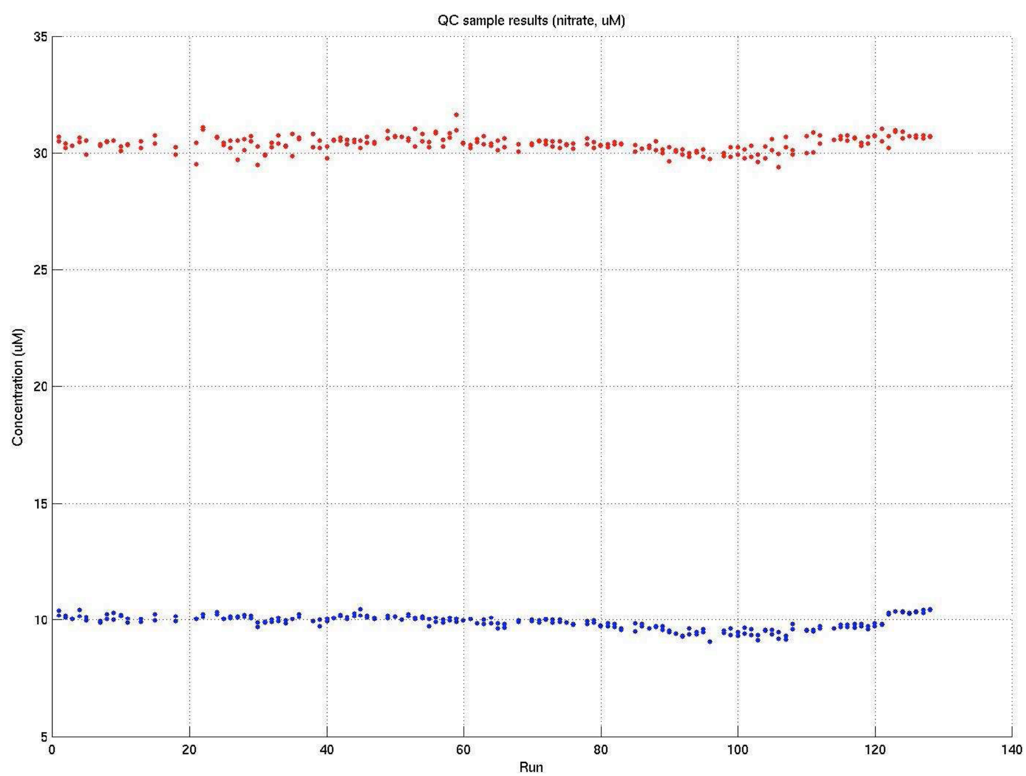
SRM results from the original calibrations.



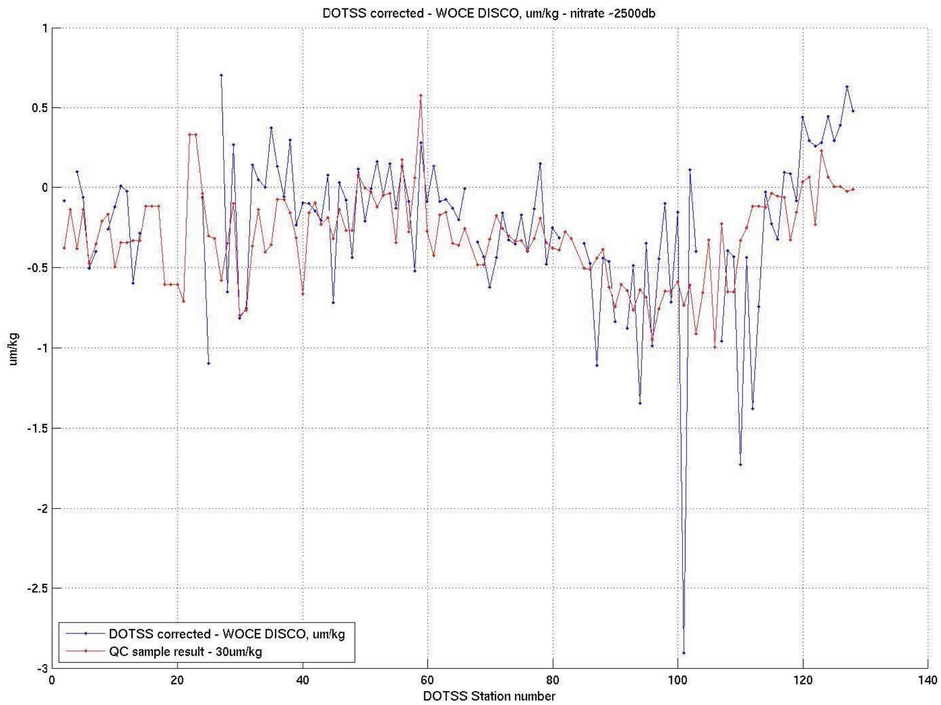
SRM results after inclusion of average RI and blank values, then calibration with the next highest calibrant.



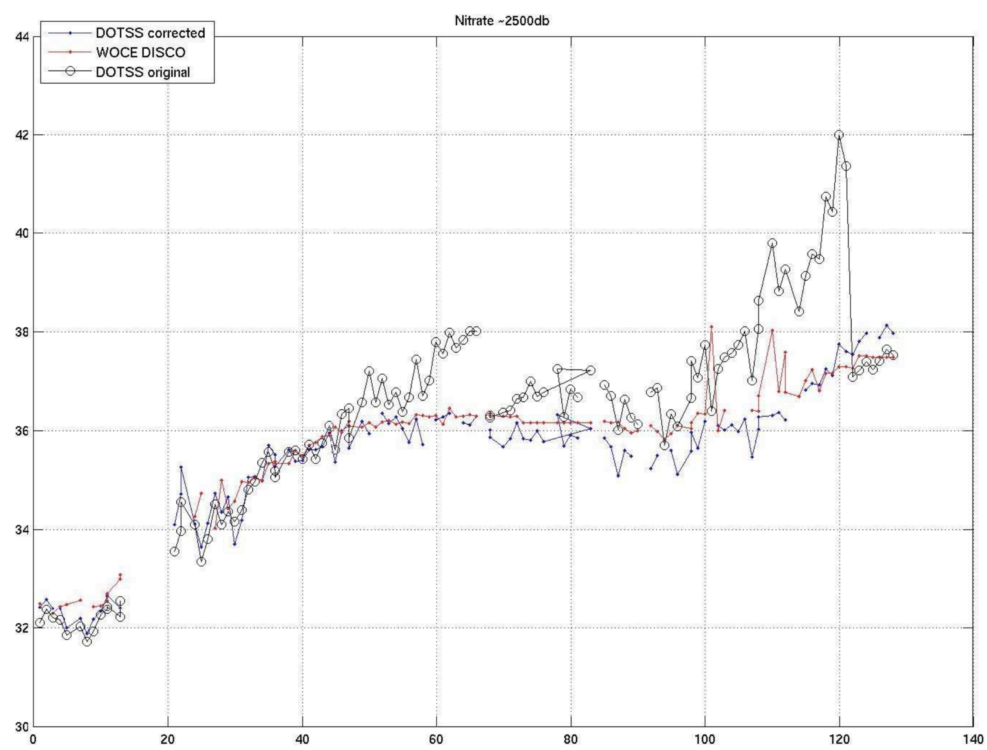

QC sample results



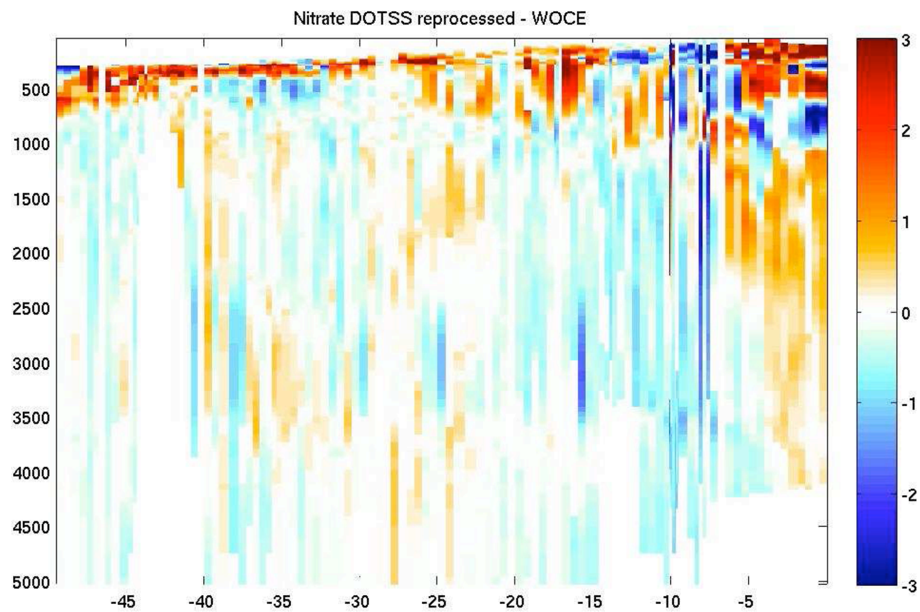
QC sample results and DOTSS-WOCE results:

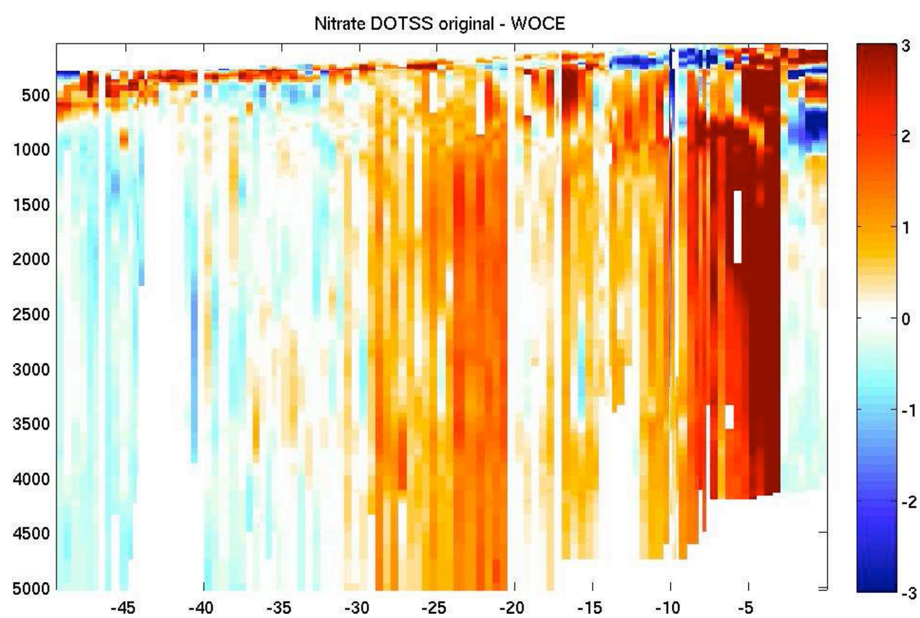



Comparison with WOCE data and original DOTSS data at 2500db after inclusion of average RI and blank values, then calibration with the next highest calibrant.



Comparison with WOCE data and original DOTSS data after inclusion of average RI and blank values, then calibration with the next highest calibrant.

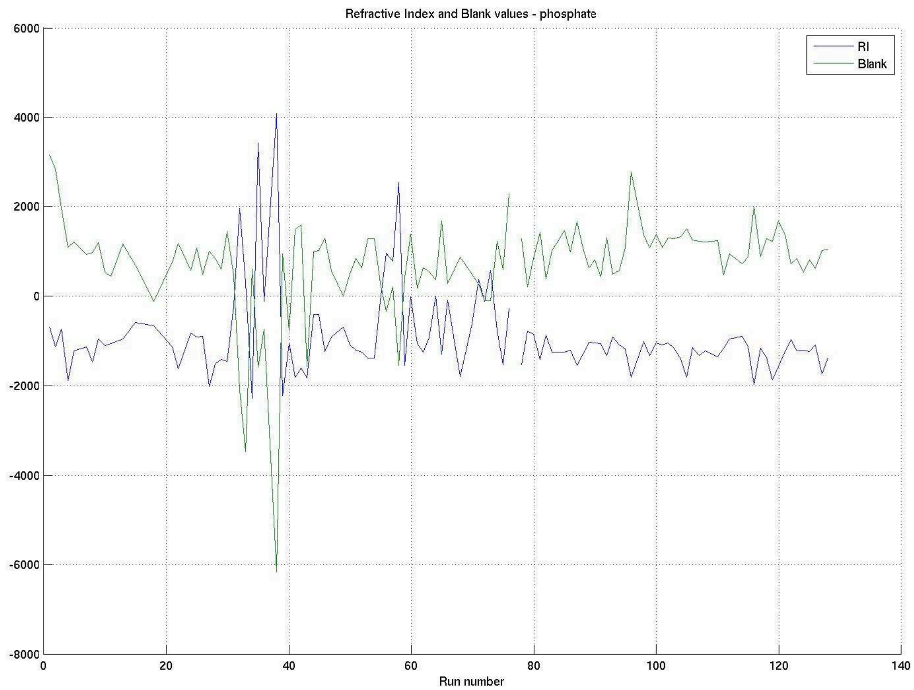


# Corrections to Phosphate data

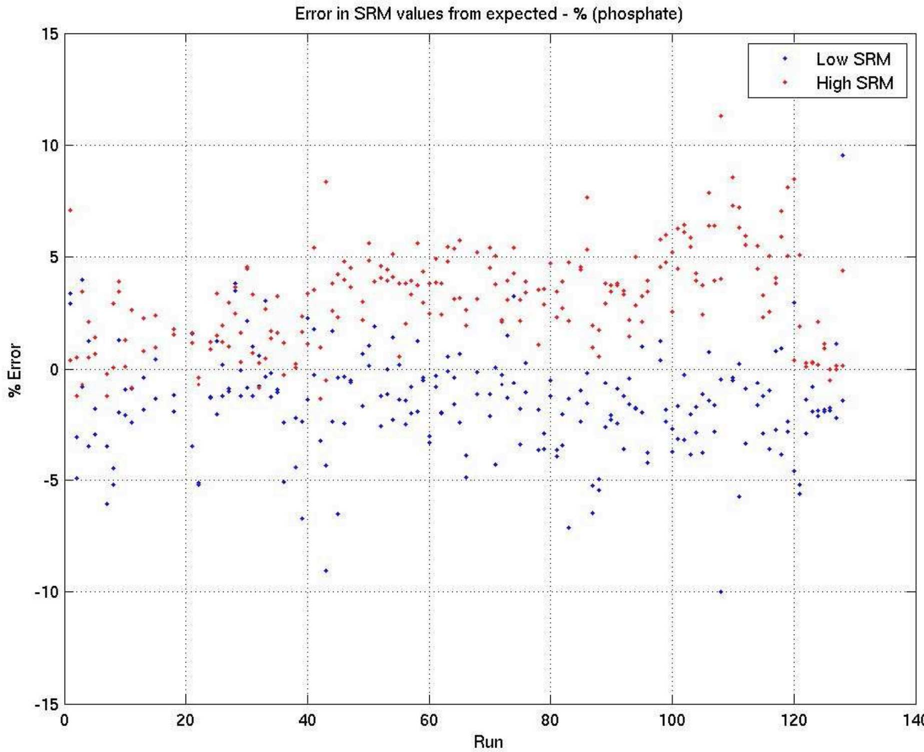
1. Mean RI and blank values subtracted from peak heights: The mean RI and blank values for all runs was subtracted from the peak heights during the calculations, rather than the individual run's values.

   Refractive Index and blank values for each run.

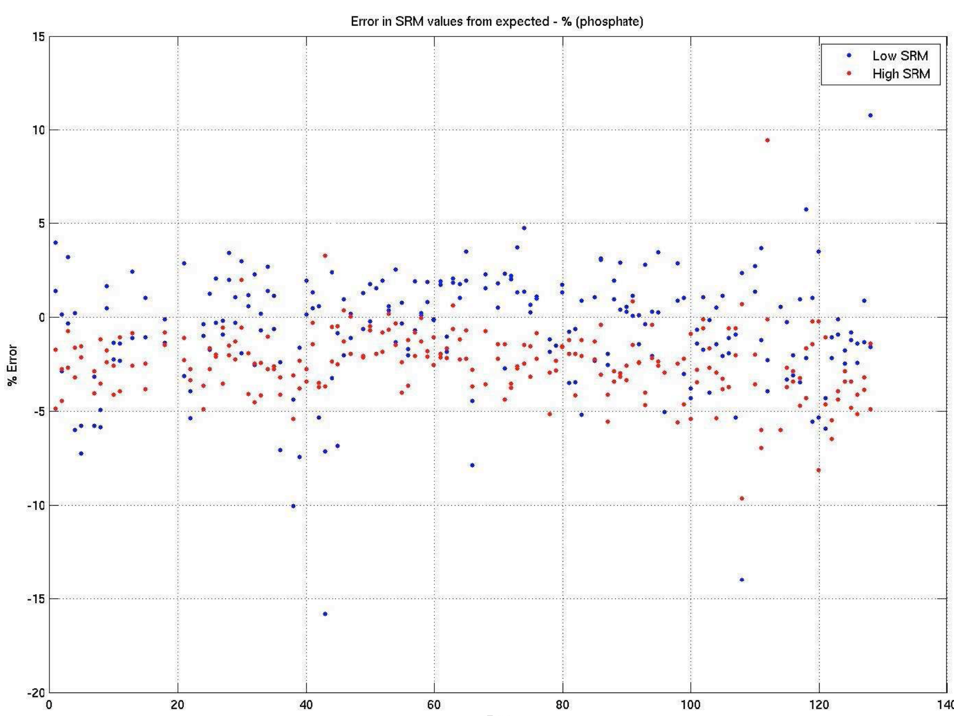



2. Recalculation of data with sensitivity factors from the next highest calibrant. Closer evaluation of the WOCE method (looking at actual OSU runs) showed that OSU only utilised one standard when calculating the sensitivity factors. This makes sense when the system is completely linear and the sample concentrations are close to the calibrant concentration used. For this data, the next highest calibrant from the sample concentration was used to calculate the concentration.

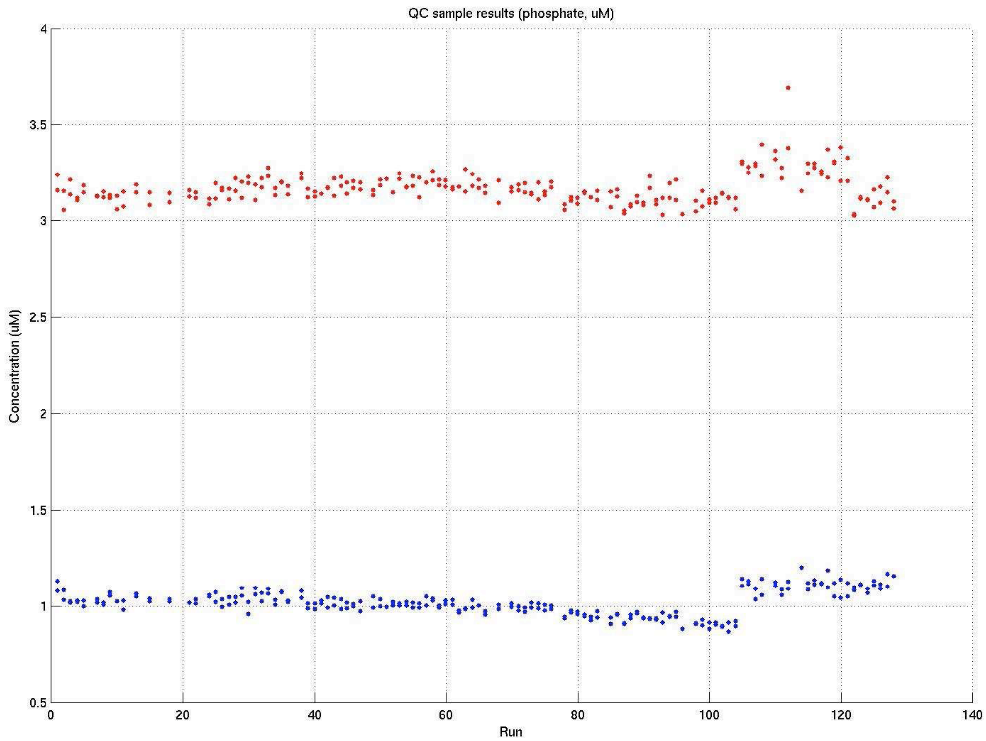
SRM results from the original calibrations.



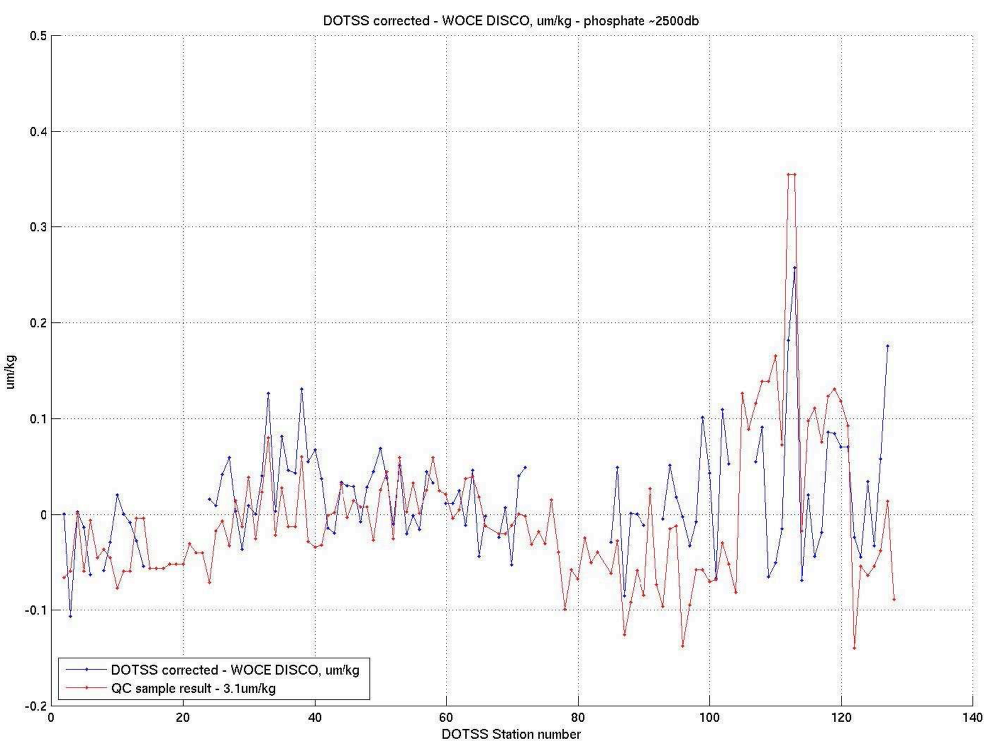

SRM results after inclusion of average RI and blank values, then calibration with the next highest calibrant.



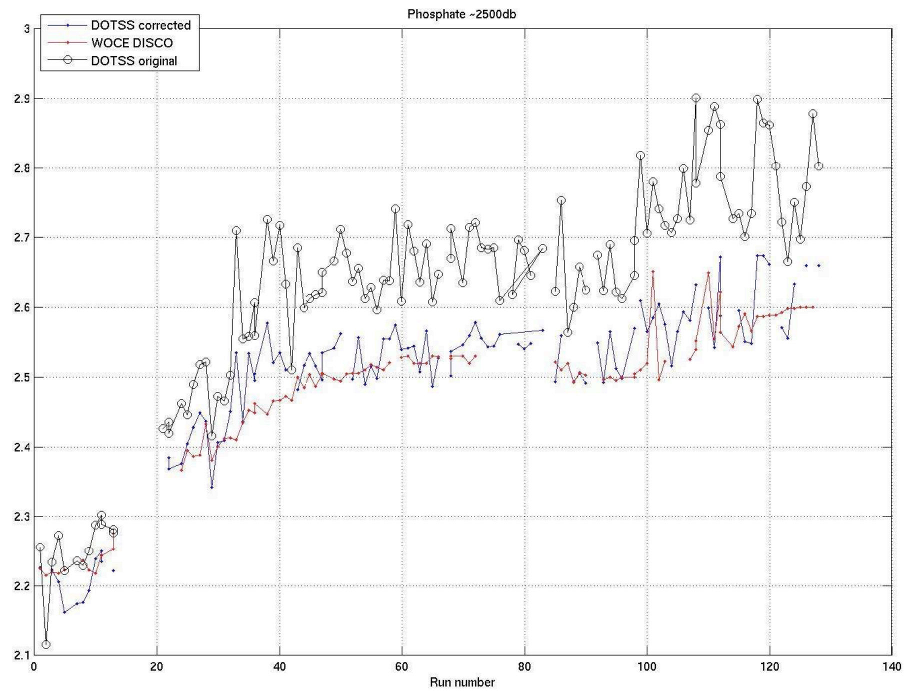
QC sample results:



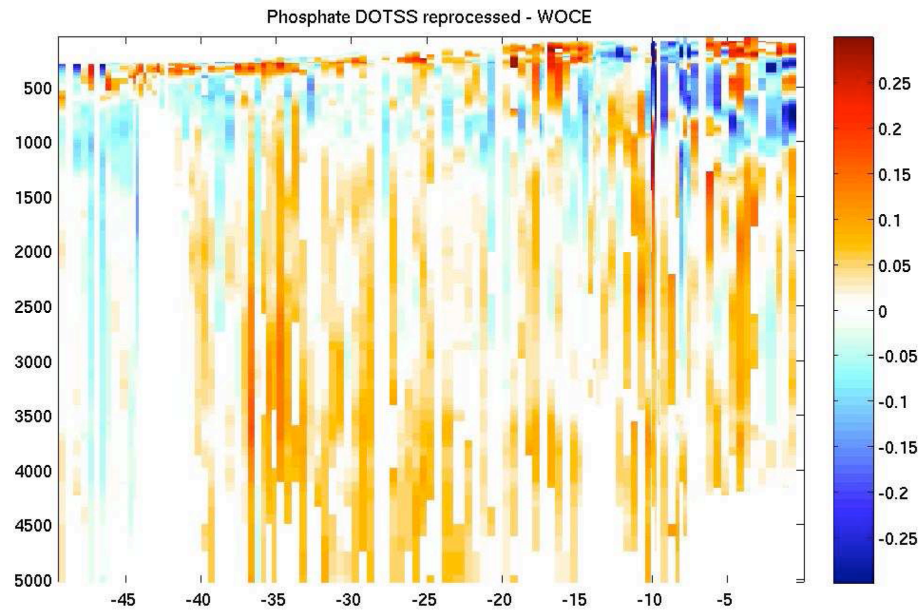

QC sample results and DOTSS-WOCE results:

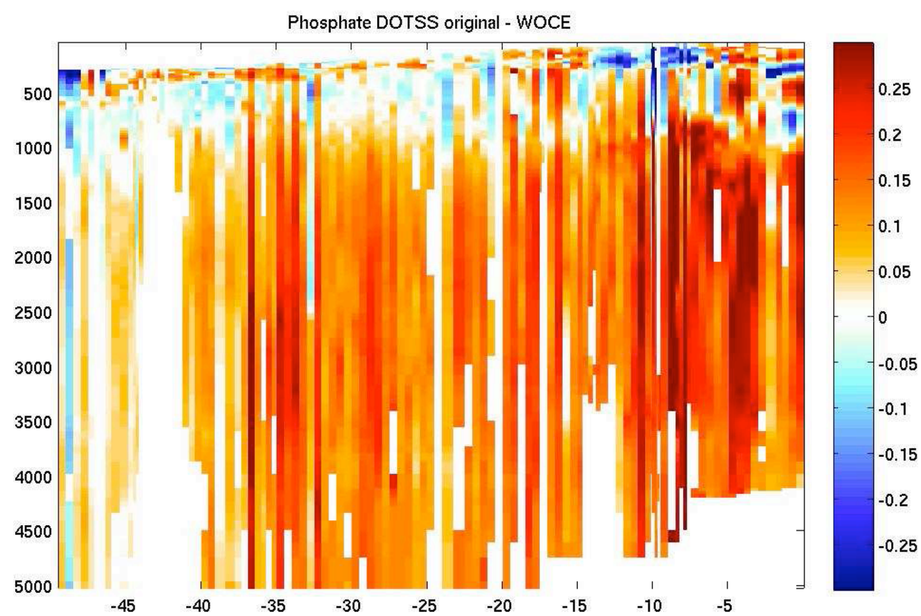


Comparison with WOCE data and original DOTSS data at 2500db after inclusion of average RI and blank values, then calibration with the next highest calibrant.



Comparison with WOCE data and original DOTSS data after inclusion of average RI and blank values, then calibration with the next highest calibrant.

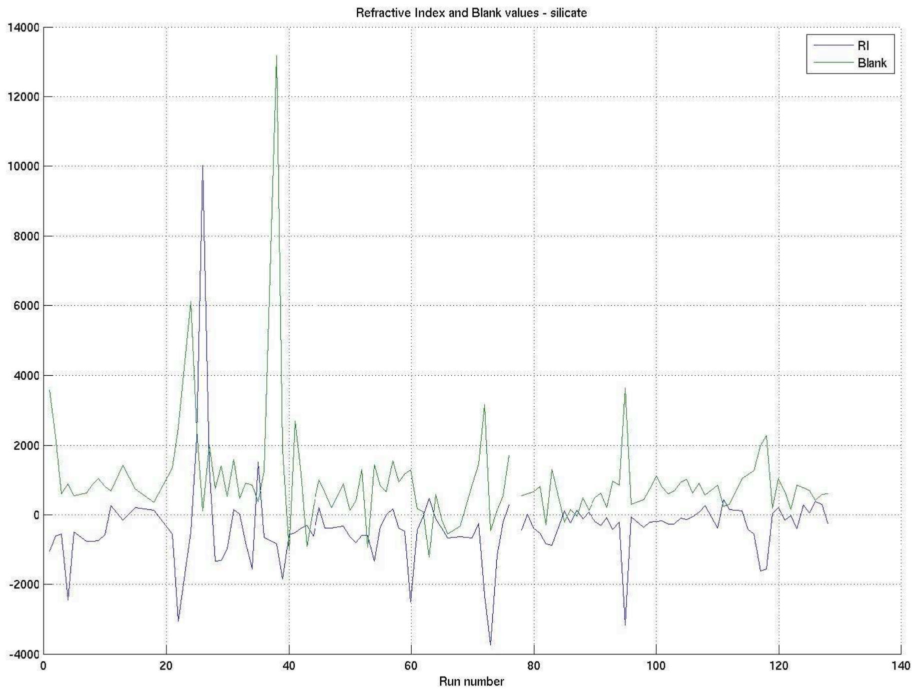


## Corrections to Silicate data

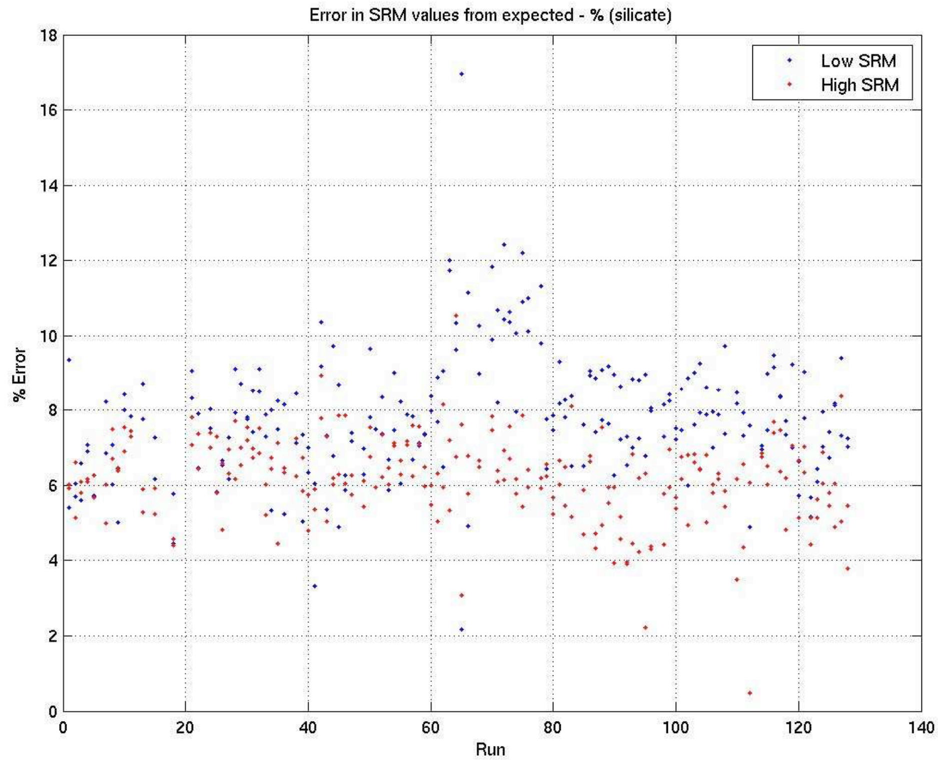
1. Mean RI and blank values subtracted from peak heights: The mean RI and blank values for all runs was subtracted from the peak heights during the calculations, rather than the individual run's values.

Refractive Index and blank values for each run.

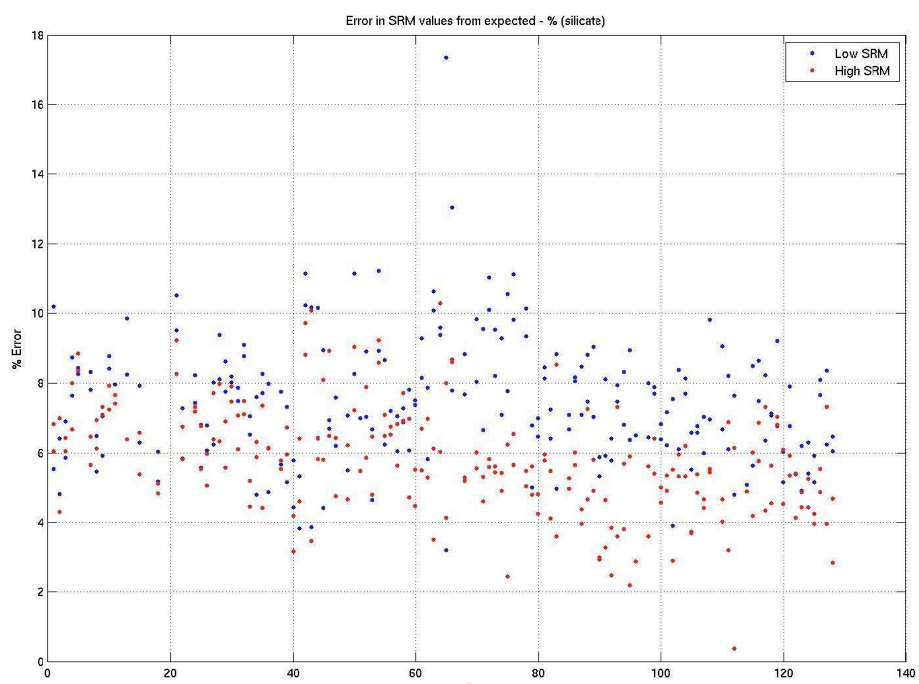



2. Recalculation of data with sensitivity factors from the closest calibrant. Closer evaluation of the WOCE method (looking at actual OSU runs) showed that OSU only utilised one standard when calculating the sensitivity factors. This makes sense when the system is completely linear and the sample concentrations are close to the calibrant concentration used. For this data, the next highest calibrant from the sample concentration was used to calculate the concentration.

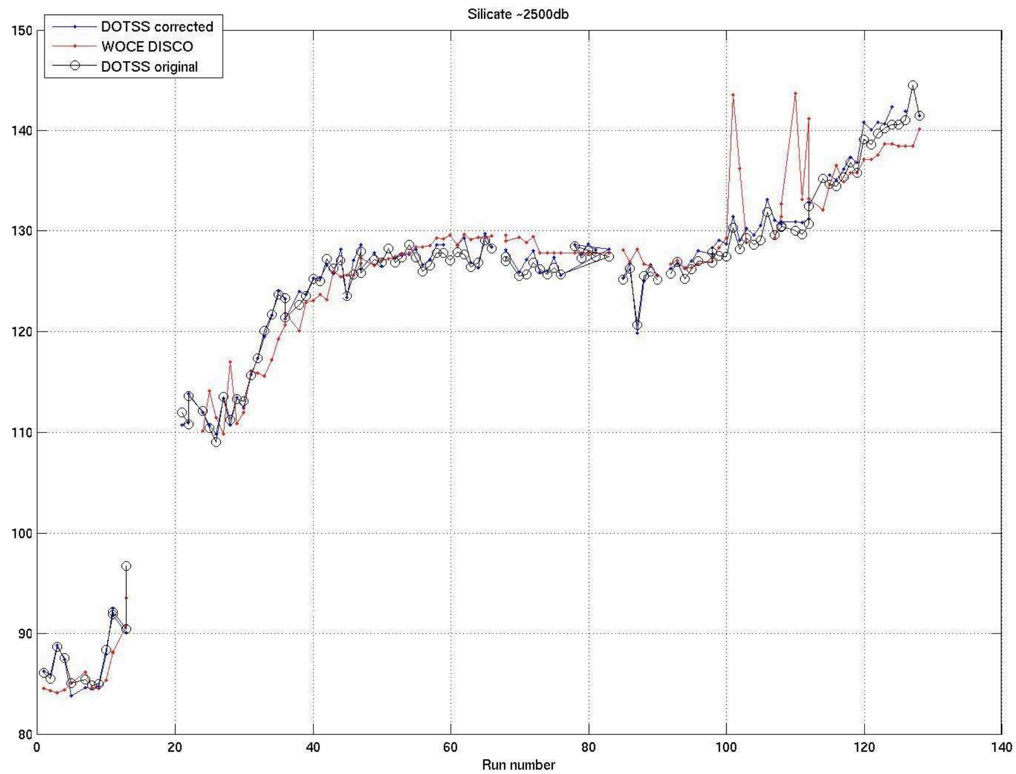
Original SRM results.



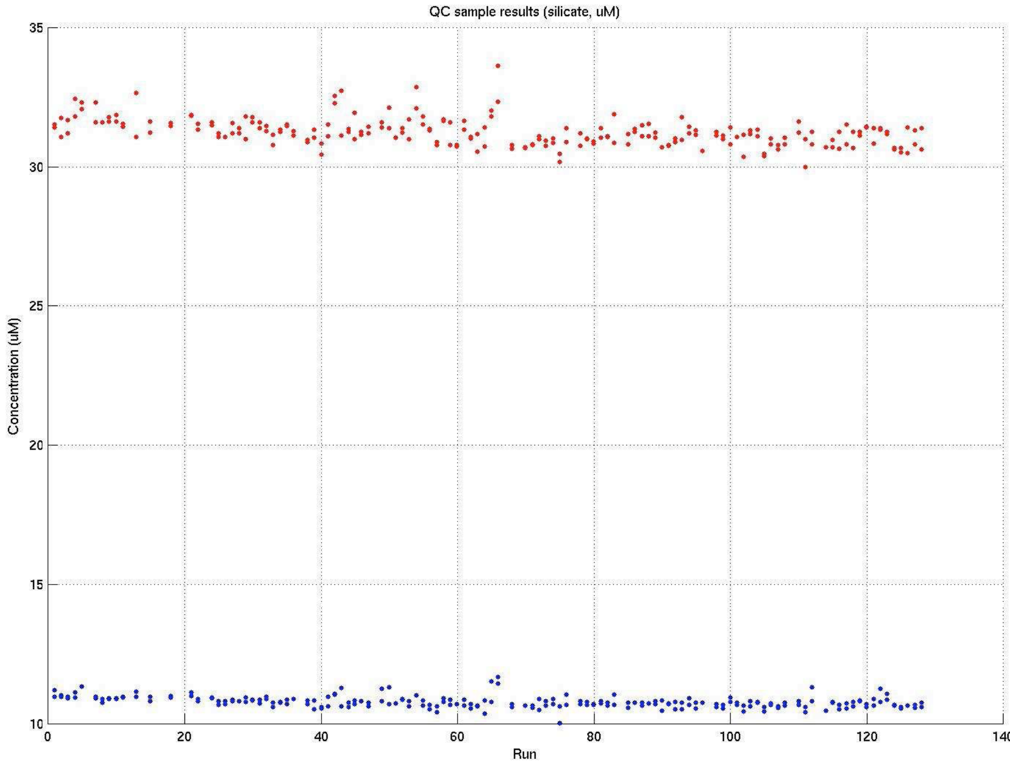

SRM results after inclusion of average RI and blank values, then calibration with the closest calibrant.

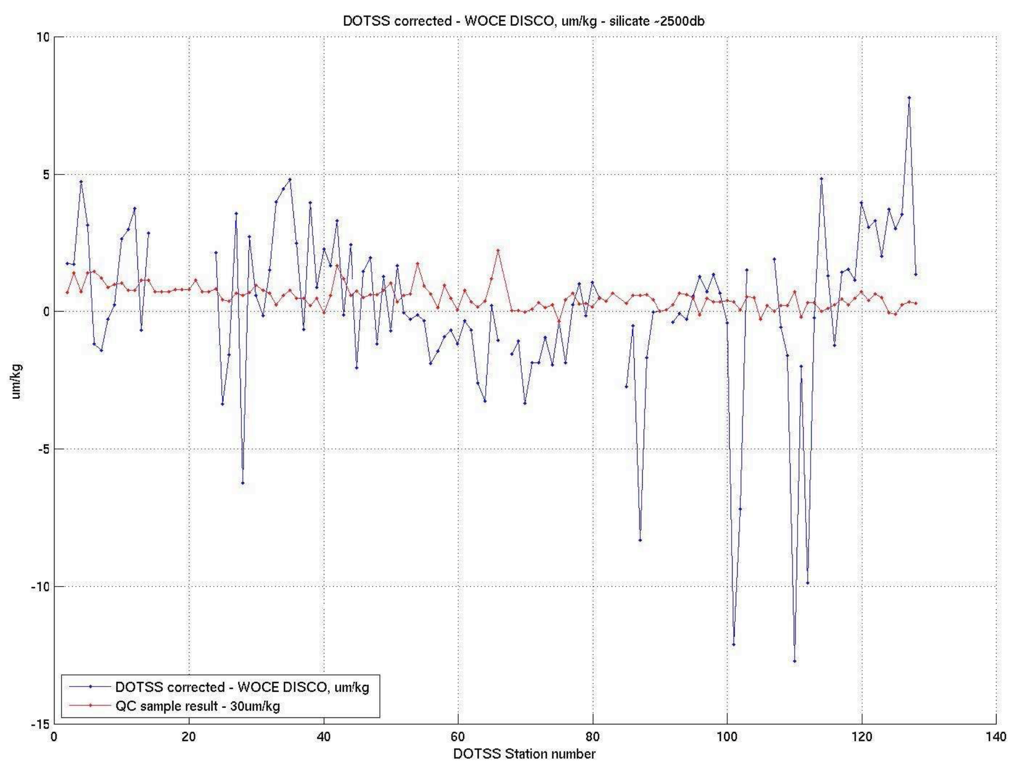


Comparison with WOCE data and original DOTSS data at 2500db after inclusion of average RI and blank values, then calibration with the closest calibrant.

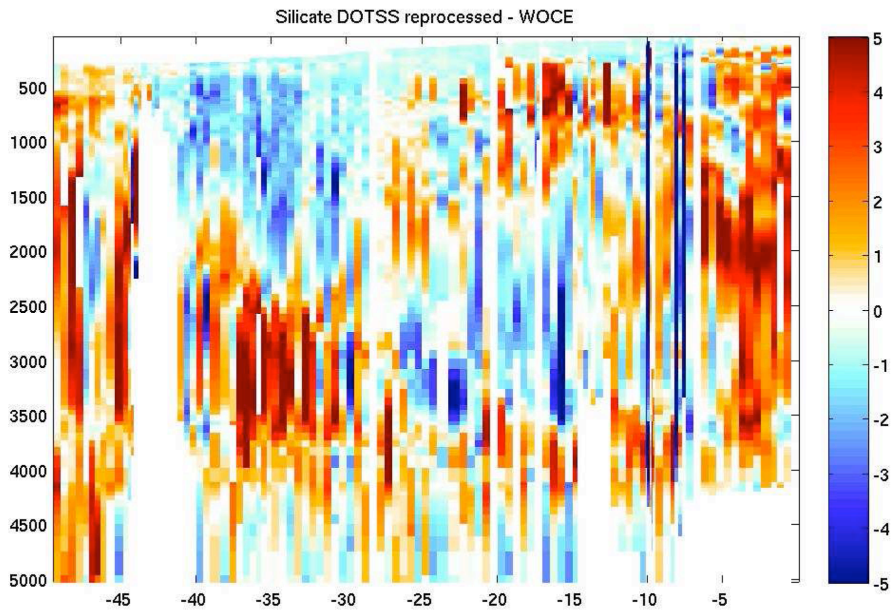


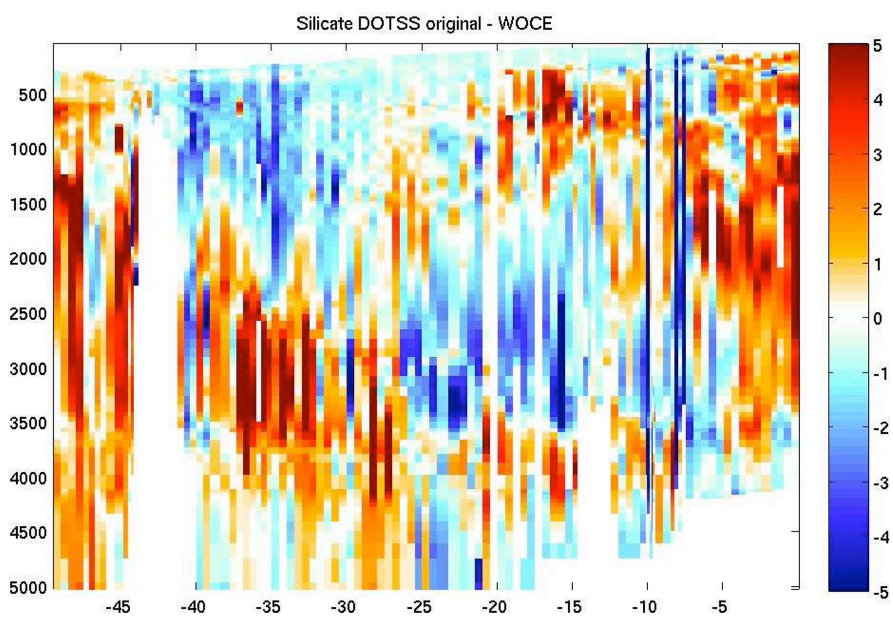
QC sample results: QC sample results and DOTSS-WOCE results:



Comparison with WOCE data and original DOTSS data after inclusion of average RI and blank values, then calibration with the closest calibrant.



## Conclusions

The data from this voyage is very noisy. The analysis for nitrate and phosphate was flawed, and the results difficult to repair. The bias in the nitrate and phosphate results was very much improved by calibration of the results using the f value of the next-highest calibrant, and the noise between runs was improved by using a mean refractive index and reagent blank value. Sensitivity (f-value) is calculated as

$$f = (A_C - A_2)\ {}^{C}{}_{a}$$

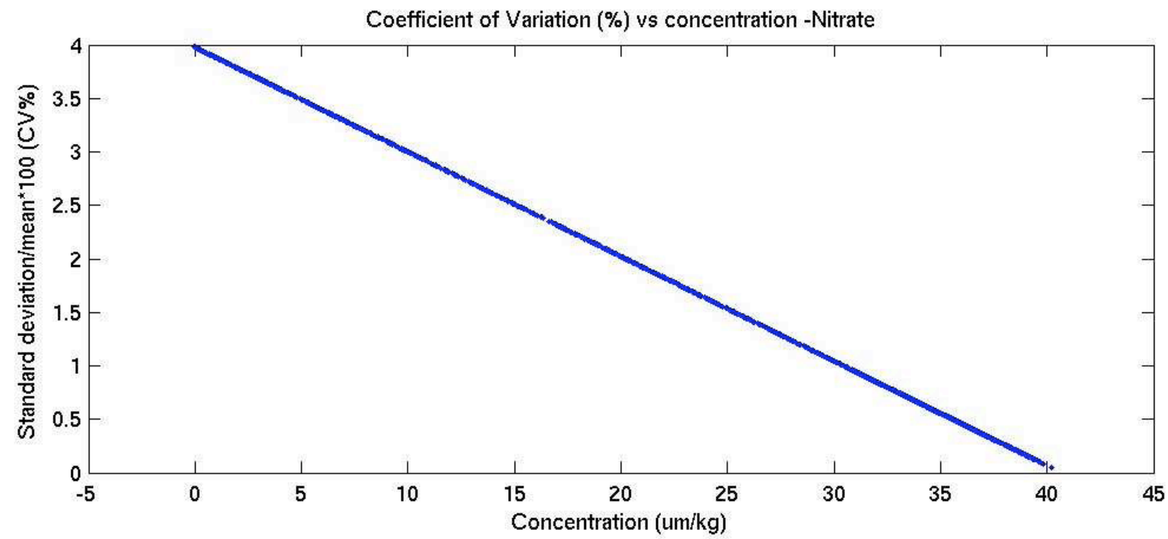
Where $C_a$ is the calibrant concentration, $A_C$ is the absorbance of the calibrant and $A_2$ is the absorbance of the matrix (or zero calibrant). To calculate the concentration of a sample, the peak height is multiplied by its regressed f value.

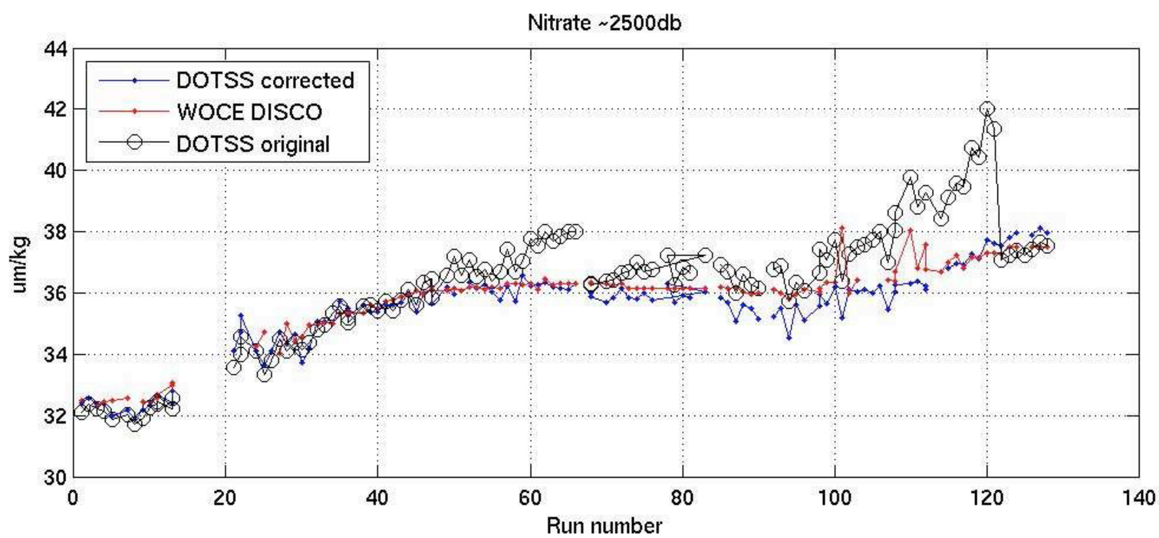
The source of the bias in the results may be attributed to one or all of the following:

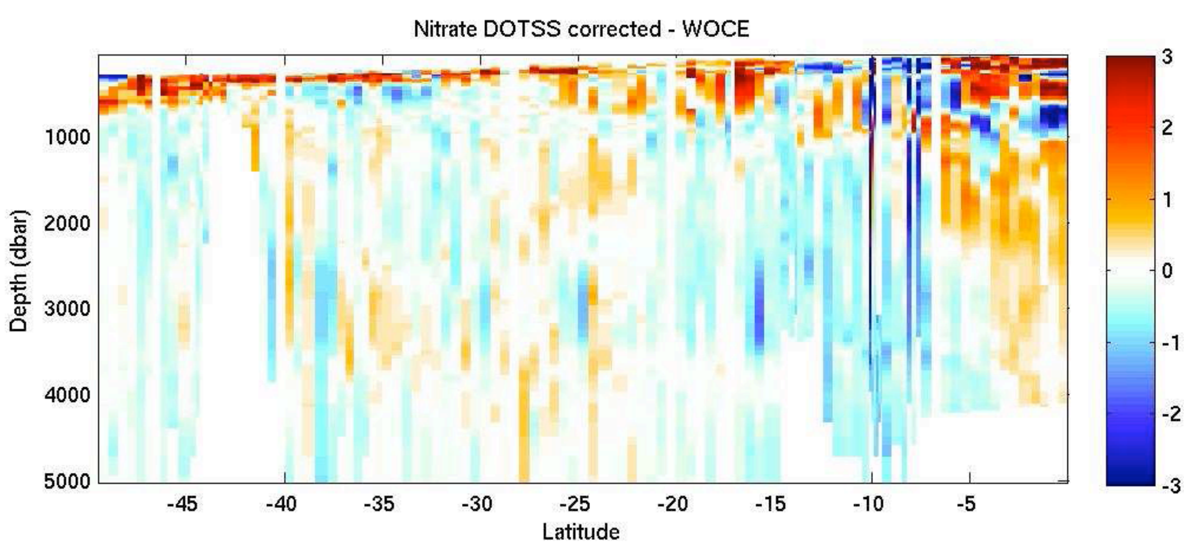
- Poor performance of the instrument at the time of analysis was not addressed immediately, and this is the main source of the bias. In particular, not cleaning the system regularly seems to be the main problem.
- Post-run analysis – positioning of the baseline markers during post-run analysis could result in an offset.
- Errors during calibrant make-up. The source of the inter-run noise may be attributed to one or all of the following:
- Instrumental noise – the Alpkem system was notoriously noisy.
- Errors during calibrant make-up.
- Contamination of samples during sampling/analysis.

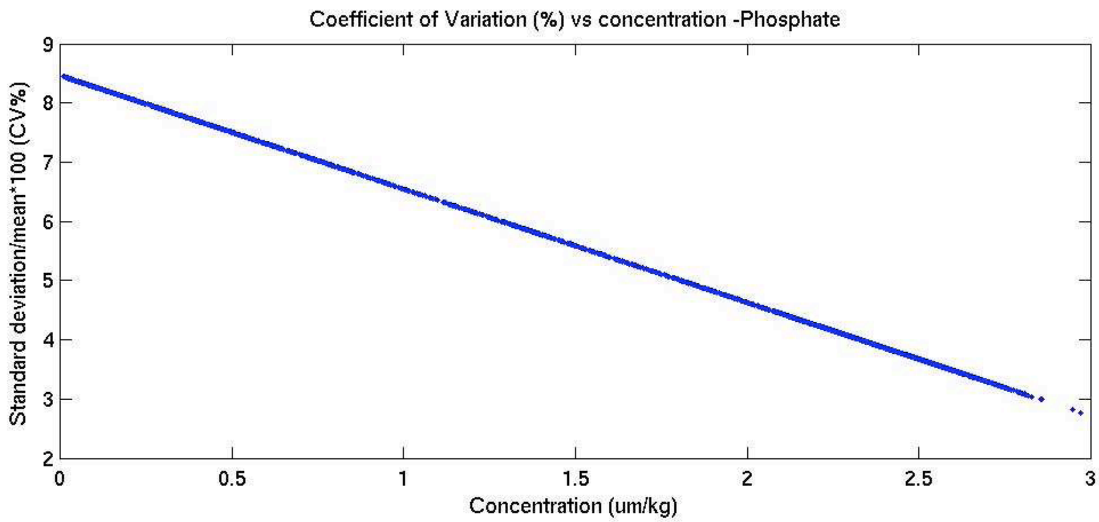
Estimation of error in the results

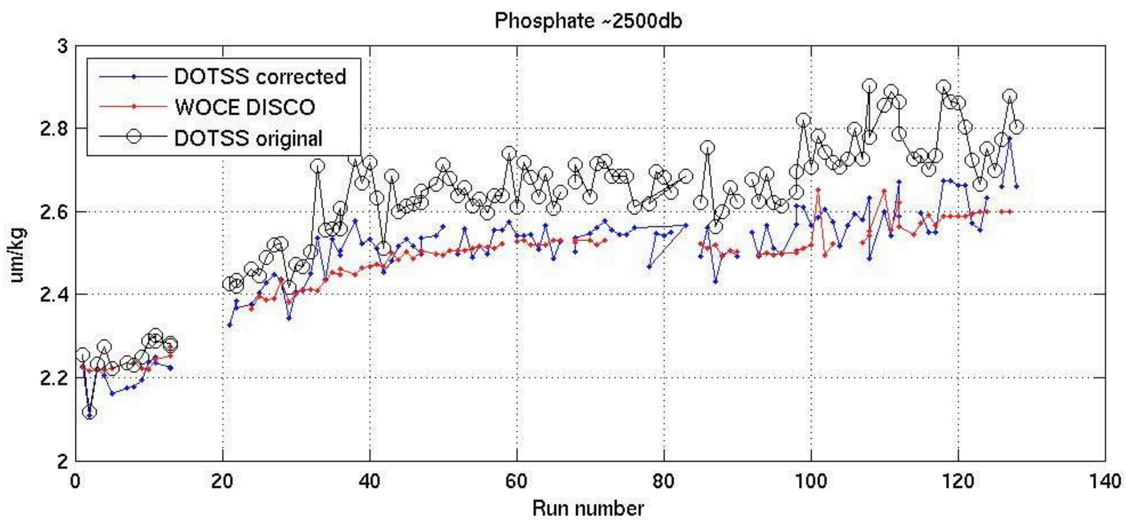
Using the final method of calibration, the coefficient of variation in the results was calculated (based on a pooled standard deviation of the QC samples that were run through the entire voyage). Below are the coefficient of variation results for the final results. The average coefficient of variation for the results is: Nitrate/Nitrite: 1.64% Silicate: 1.35% Phosphate: 5.3%

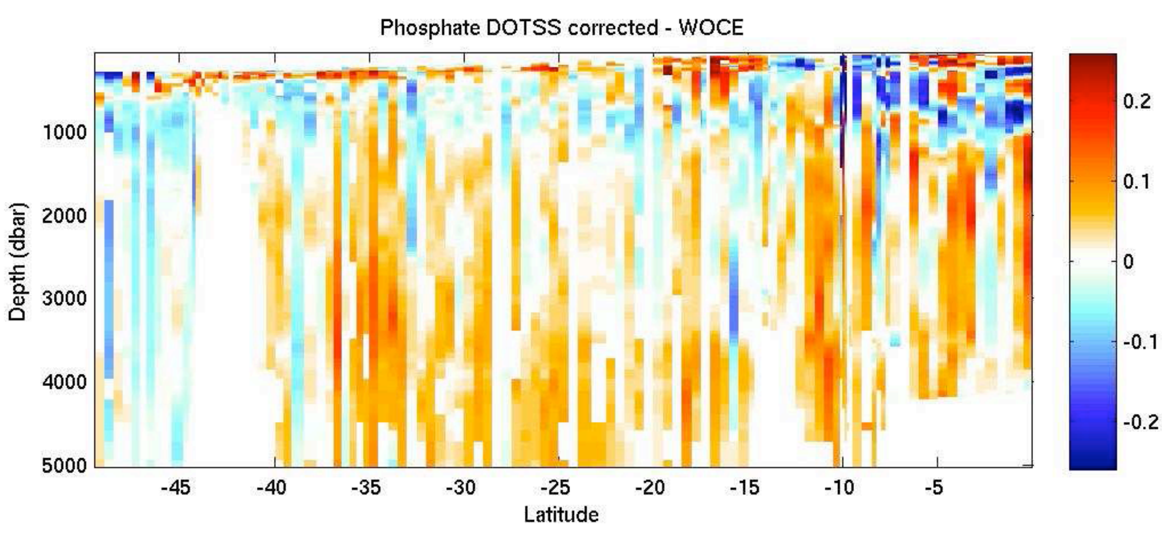

Coefficient of Variation (%) vs concentration -Nitrate
Standard deviation/mean*100 (CV%)
Concentration (um/kg)

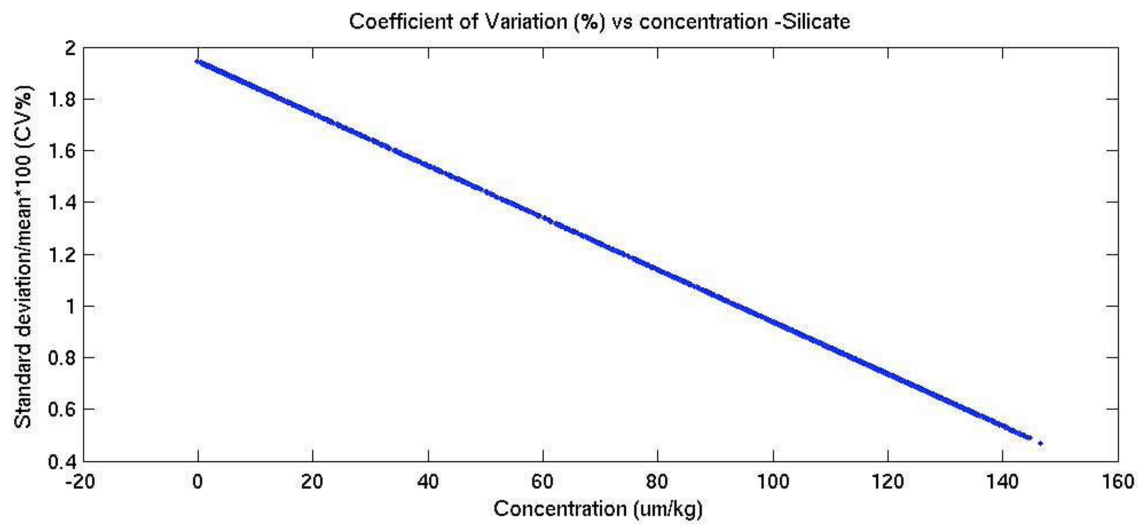

Nitrate ~2500db
DOTSS corrected
WOCE DISCO
DOTSS original
um/kg
Run number

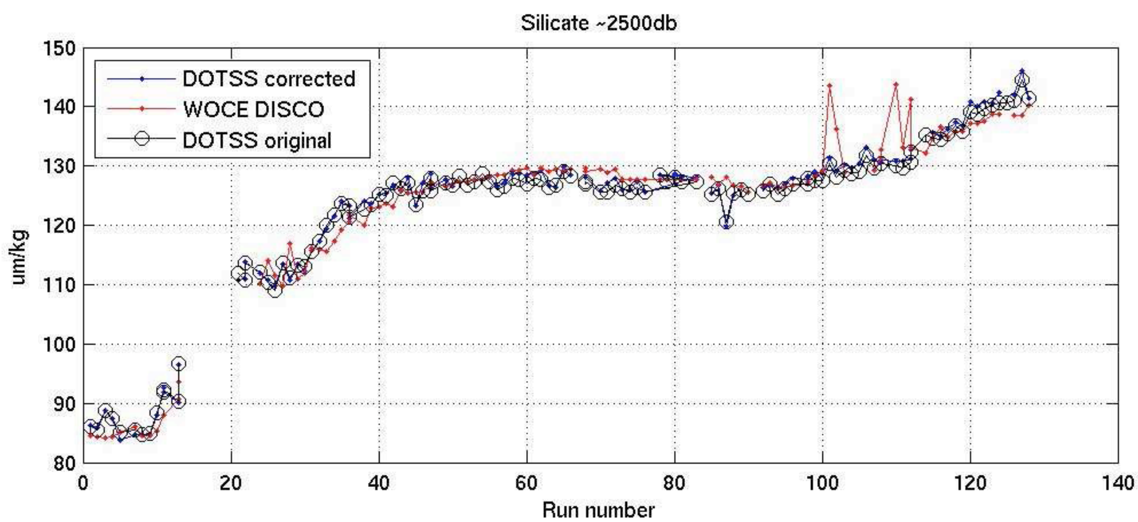

Nitrate DOTSS corrected - WOCE
Depth (dbar)
Latitude

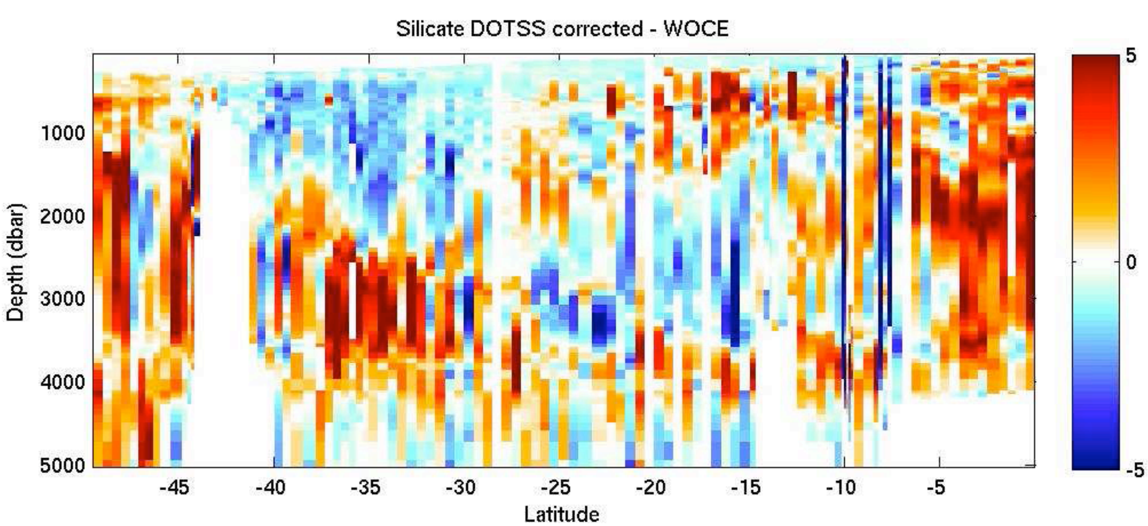

Coefficient of Variation (%) vs concentration -Phosphate
Standard deviation/mean*100 (CV%)
Concentration (um/kg)


Phosphate ~2500db
DOTSS corrected
WOCE DISCO
DOTSS original
um/kg
Run number


Phosphate DOTSS corrected - WOCE
Depth (dbar)
Latitude


Coefficient of Variation (%) vs concentration -Silicate
Standard deviation/mean*100 (CV%)
Concentration (um/kg)


Silicate ~2500db
DOTSS corrected
WOCE DISCO
DOTSS original
um/kg
Run number


Silicate DOTSS corrected - WOCE
Depth (dbar)
Latitude

## References

WOCE Operations Manual, Volume 3. WHP Office Report WHPO 91-1. WOCE Report No. 68/91. November 1994, Revision 1.

CSIRO Hydrochemistry Operations Manual (1999). Cowley, R., Critchley, G., Eriksen, R., Latham, V., Plascke, R., Rayner, M., Terhell, D

## Chlorofluorocarbons (CFCs)

Principal Investigators Mark Warner and John Bullister
Sample collection and analysis provided by Frederick Menzia, and Regina Cesario

Specially designed 10-l water sample bottles were used on the cruise to help reduce CFC contamination during R/V Franklin cruise FR0105 Between 50 S and the equator nominally along 170 W.

Samples for the analysis of dissolved CFC-11, CFC-12 and CFC-113 were drawn from approximately 1900 of the water samples collected during the expedition. Samples for carbon tetrachloride (CCl4 or CFC-10) analysis were drawn from approximately one quarter of the samples. When taken, water samples for CFC analysis were usually the first samples drawn from the 10-l bottles. Care was taken to co-ordinate the sampling of CFCs with other samples to minimize the time between the initial opening of each bottle and the completion of sample drawing. In most cases, dissolved oxygen, DIC, and alkalinity were collected within several minutes of the initial opening of each bottle. To minimize contact with air, the CFC samples were drawn directly through the stopcocks of the 10-l bottles into 100-ml precision glass syringes equipped with 2-way metal stopcocks. The syringes were immersed in a holding tank of clean seawater until analyzed.

To reduce the possibility of contamination from high levels of CFCs frequently present in the air inside research vessels, the CFC extraction/analysis system and syringe holding tank were housed in a modified 20' laboratory van on the aft deck of the ship.

For air sampling, a 45 meter length of 3/8" OD Dekaron tubing was run from the CFC lab van to the bow of the ship. A flow of air was drawn through this line into the CFC van using an Air Cadet® pump. The air was compressed in the pump, with the downstream pressure held at 1.5 atm using a back-pressure regulator. A tee allowed a flow (100 cc min-1) of the compressed air to be directed to the gas sample valves, while the bulk flow of the air (>7 l min-1) was vented through the back pressure regulator. Air samples were only analyzed when the relative wind direction was within 60 degrees of the bow of the ship to reduce the possibility of shipboard contamination. The Air Cadet pump was run for at least 60 minutes prior to analyzing each batch of air samples to insure that the air inlet lines and pump were thoroughly flushed

Concentrations of CFC-11, CFC-12 and CFC-113 in air samples, seawater and gas standards on the cruise were measured by shipboard electron capture gas chromatography (EC-GC), using techniques similar to those described by Bullister and Weiss (1988). For seawater analyses, a 35-ml aliquot of seawater from the glass syringe was transferred into the glass sparging chamber. The dissolved CFCs in the seawater sample were extracted by passing a supply of CFC-free purge gas through the sparging chamber for a period of 4 minutes at 70 cc min-1. Water vapor was removed from the purge gas during passage through an 18 cm long x 3/8 inch diameter glass tube packed with the desiccant magnesium perchlorate. The sample gases were concentrated on a cold-trap consisting of a 1/8 inch OD stainless steel tube with an ~7 cm section packed tightly with Porapak N (60-80 mesh). To cool the trap, isopropanol cooled by a Neslab Cryocool® refrigeration system was forced from a reservoir beneath the trap to a level above the

packing with a stream of compressed nitrogen. After quickly bringing the isopropanol to the top of the trap, a low flow of nitrogen was bubbled through the bath to reduce gradients and maintained a temperature of -20°C. After 4 minutes of purging the seawater sample, the sparging chamber was closed and the trap was held open for an additional 1 minute to allow nitrous oxide (N20) to pass through the trap and thereby minimize its interference with CFC-12. The trap was isolated, the cold isopropanol in the bath was drained, and the trap was heated electrically to 125°C. The sample gases held in the trap were then injected onto a precolumn (30 cm of 1/8 inch O.D. stainless steel tubing packed with 80-100 mesh Porasil C, held at 90°C), for the initial separation of the CFCs and other rapidly eluting gases from the more slowly eluting compounds. The CFCs then passed into the main analytical column (~183 cm of 1/8 inch OD stainless steel tubing packed with Carbograph 1AC, 80-100 mesh, held at 90°C) for final separation, and into the EC detector for quantification.

The analysis of carbon tetrachloride was made on a separate, but nearly identical apparatus to the electron capture-gas chromatography system used in the analysis of CFC-11, CFC-12 and CFC-113 (Bullister and Weiss, 1988). Samples were drawn in the same type of syringes used for the CFC analysis. In the CCl4 system, the sample injection port was flushed with 30-40 ml of sample before injecting sample into a calibrated loop (~30 ml). After filling, an additional 30 ml of water was pushed through the loop and allowed to overflow. For analysis, a valve was switched and the water sample held in the loop was pushed into the stripper with the same CCl4 free nitrogen that was used to strip the sample. The gases removed from the sample were dried while passing through an ~18 cm x 3/8 inch OD tube of magnesium perchlorate and concentrated on a trap packed with four inches of Porapak N and held at -30°C during trapping. At the conclusion of stripping, the trap was heated electrically and the contents swept onto the precolumn (0.53mm I. D. x 30 meters, DB624 capillary column, 45°C)) with clean nitrogen. The desired gases passed on to the main analytical column (0.53mm I. D. x 30 meters, DB624 capillary column, 45°C), before the precolumn vented the later peaks. All other aspects of the analysis were the same as the CFC analysis.

Both of the analytical systems were calibrated frequently using a standard gas of known CFC composition. Gas sample loops of known volume were thoroughly flushed with standard gas and injected into the system. The temperature and pressure were recorded so that the amount of gas injected could be calculated. The procedures used to transfer the standard gas to the trap, precolumn, main chromatographic column and EC detector were similar to those used for analyzing water samples. Two sizes of gas sample loops were present in the CFC analytical system, while four calibrated sample loops were used in the CCl4 system. Multiple injections of these loop volumes could be made to allow the system to be calibrated over a relatively wide range of concentrations. Air samples and system blanks (injections of loops of CFC-free gas) were injected and analyzed in a similar manner. The typical analysis time for a seawater, air, standard or blank sample was 15 minutes on the CFC system and 20 minutes on the CCl4 system.

Concentrations of the CFCs and CCl4 in air, seawater samples and gas standards are reported relative to the SIO93 calibration scale (Cunnold, et. al., 1994). Concentrations in air and standard gas are reported in units of mole fraction CFC in dry gas, and are typically in the parts-per-trillion (ppt) range. Dissolved CFC and CCl4 concentrations are given in units of picomoles per kg seawater (pmol kg-1). CFC and CCl4 concentrations in air and seawater samples were determined by fitting their chromatographic peak areas to multi-point calibration curves, generated by injecting multiple sample loops of gas from a working standard (PMEL cylinder 33790 for CFC-11, CFC-12 and CFC-113; PMEL cylinder 33780 for CCl4) into the analytical instrument. The concentrations of CFC-11 and CFC-12 in this working standard were calibrated before and after the cruise versus a primary standard (36743) (Bullister, 1984). No measurable drift in the concentrations of CFC-11 and CFC-12 in the working standard could be detected during this interval. Full range calibration curves were run at intervals of 3 days during the cruise. Single injections of a fixed volume of standard gas at one atmosphere were run at intervals of 1 to 2 hours to monitor short term changes in detector sensitivity.

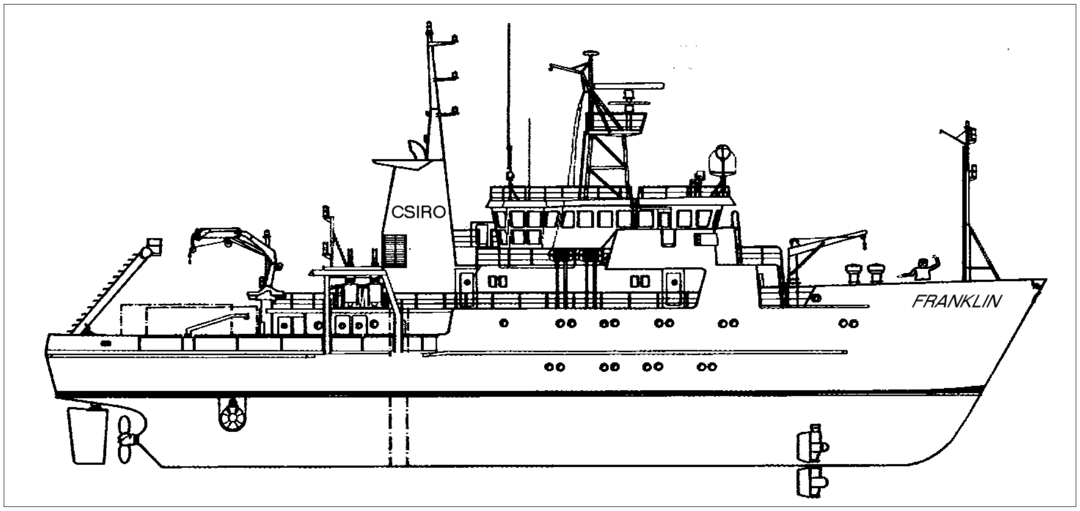
Extremely low (<0.01 pmol kg-1) CFC concentrations were measured in water between 2000 and 3000 meters at the Northern end of the section between 15 ºS and 45 ºS along this section. Based on the median of CFC concentration measurements at these depths, which is believed to be nearly CFC-free, blank corrections will be applied to the data set. If the measured CFC concentration for a sample is very low, subtracting a blank can result in a very small negative number reported. Blank corrections will be applied to the CCl4 data if necessary.

On this expedition, we estimate precision (1 standard deviation) of 1-2% or 0.005 pmol kg-1 (whichever is greater) for dissolved CFC-11, 2% or 0.005 pmol kg-1 (whichever is greater) for dissolved CFC-12 measurements. F-113 and CCl4 precision is yet to be determined as there was F113 contamination for most of the cruise.

A number of water samples had clearly anomalous concentrations relative to adjacent samples for one or more of the trace gases. These anomalous samples appeared to occur more or less randomly during the cruise although more frequently for F12 and F-113, and were not clearly associated with other features in the water column (e.g. elevated oxygen concentrations, salinity or temperature features, etc.). This suggests that the high values were due to individual, isolated low to moderate level CFC contamination events. The source of the contamination was eventually tracked down to eucalyptus oil that is regularly injected into the ships air conditioning unit. It appears that some of the oil was collecting on the bottles and absorbing CFCs. Measured concentrations for all samples will be included in subsequent reports, but those showing contamination will be given a quality flag of either 3 (questionable measurement) or 4 (bad measurement).

# APPENDIX A -- Marine Insturmentation

*(Lindsay MacDonald)*




## CTD

The Seabird 911 CTD # 20 itself performed very reliably throughout this leg of the cruise however some problems were encountered with some of the sensors.

## Conductivity Sensors

The secondary conductivity sensor had failed on the final cast of the first leg. It had cracked at pressure and no longer tracked the primary cell which agreed with the bottle data.

It was swapped with serial # 042234 from the spare CTD # 19.

However when this cast was plotted the following day it was found that this cell had tracked the primary to 1000m and then started producing spurious data and eventually no output.

The remaining sensor # 042235 from the spare CTD was swapped for this unit. It worked perfectly for the remainder of the cruise.

## D.O. Sensor

There seemed to be the occasional voltage jumps or steps displaying in the dissolved oxygen sensor early in leg2. This sensor along with its electronics package had been swapped from the spare unit on leg 1 of this cruise.

Data from the altimeter, which uses another of the analogue input channels on the CTD, were checked on the same casts as the problem oxygen data but no correlation was found. The D.O. data plot then seemed to settle down. On 29/6/01 the D.O. sensor showed very unstable readings. The D.O. sensor was removed from its package and swapped with that on the spare CTD. It had been used on leg 1 prior to the swap. New oil and O rings were used. The D.O. output then gave good stable readings, which seemed to follow that of the WOCE cruise data a few years prior to this cruise.

## Bottle Firing Failures

Bottle # 18 failed several times. It was thought that there maybe some foreign matter lodged in the mechanism. It was tested several times using random firing procedures by sending the appropriate commands to the annex port. Rubber bands were used to simulate a bottle lanyard but with a lot lower tension in air.

It was discovered that the lanyard from bottle # 18 was most likely catching on a cable tie on the seacable going to the load cell. The cable ties were changed to a different position and some electrical tape was used to cover the cables and the problem did not re-emerge.

The lanyard from Bottle position # 19 also began catching but this time in the gap left at the top of the rosette frame join. This should be filled with epoxy or similar to prevent this occuring again.

## Cable

At the end of the cruise the CTD cable was inspected for kinks and corrosion. The only corrosion evident was the usual surface rust. The secondary clamps on the rosette termination were opened up and inspected and found to be near new condition. A re-termination of the cable was deemed unnecessary at this stage. This should most likely be carried out in Brisbane prior to Fr0701.

## Winch Monitoring System

On the initial CTD test cast at the start of leg 2 there was no data output from the CTD winch monitoring PCB. This required the top to taken off the box and the connector supplying power and the backup battery removed and then re-installed to reset the firmware. The first time this was done carried out data was being transmitted but it was corrupted. A second reset fixed the problem. It is not very good practise to do this. There is a breaker on the ships office level that can be reset to achieve the same result.

The following night I was called from sleep to perform this once more. After this the problem did not reoccur for the remainder of the cruise.

On 21/6/01 large spikes were evident on the CTD tension continuous plot when the CTD was on board with no load on the strain gauge. This had disappeared by the next day.

## EA500 Scientific Sounder

At the beginning of leg 2 the display on the EA500 appeared very noisy. Adjustments were carried out to try and improve this. Problems were encountered locking onto the bottom once the ship was in depths over 3000 metres. Eventually on the 3rd day of leg 2 the bottom could not be found and the display was

extremely noisy. The transmit pulse could not be heard in the lower decks of the ship so the EA500 was opened up and investigated. The High Voltage Led was not illuminating. The power supply board appeared difficult to remove so a decision was made to install the spare EA500 from the Electronics Lab but keep the same transceivers. This required swapping most of the boards to the spare frame. However on power up there was no video output from this unit. The display and ethernet card was then swapped but still no display.

The power supply board was then removed from the spare unit and the original configuration with the new power supply was put together. This rectified the problem and the sounder was back in business. The problem was traced to an open circuit power resistor. Some replacements for this have been ordered from Hobart to repair the spare card on Fr06/01.

Unfortunately on the 30/6/01 the EA500 Video display stopped working. There appeared to be no EHT voltage. There are no circuits provided with this monitor and no parts kept on board which could possibly fix the problem. An old NEC Multisync monitor was found in a box in the laundry store and connected to the EA500 output. It produced a very poor display of the video output but sufficient to see the bottom and change settings. This only lasted about 1 hour before completely losing sync, vertical height and illumination.

A spare NEC multisync from Hobart will be used for Fr06 and the EA500 monitor hopefully repaired between Fr06 and 07.

## Satellite Communications

On the first day of leg 2 there were problems using email on both Inmarsat B and Minisat M.

The former reported a busy signal on every attempt for the first few days. The Minisat could be used for voice communication but not data. Resetting the annex port for the Minisat however, rectified this problem.

After approximately 4 days the Inmarsat B system began working again. The problem was most likely with ship based equipment. The fax machine however would not work on this system. The fax machine for the Optus mobilesat system which was out of range for this cruise was connected up to the Minisat system and worked successfully for the cruise.

## U.P.S.

A load test was carried out on the U.P.S. battery bank as the U.P.S. has not been holding up when the ships power failed since the ship left Hobart.

A piece of timber with three 24volt lamps wired in series was used for the load. This load drew 6.5 amps from a well charged battery.

All batteries produced a similar result with a voltage reading across the battery of approximately 12.4 volts with the load applied, except for 2. The battery on the middle shelf at the front on the RHS dropped to about 1.2 volts under load. The battery on the top shelf, front , LHS dropped voltage faster than the others and eventually after 30 or 40 seconds was down to 9.5 volts.

These batteries will be replaced when the ship gets to Brisbane at the end of Fr06/01. A spare should also be kept on the ship under trickle charge.

On the 4/7/01 on the return journey the ships engine stopped causing a power blackout. The UPS did not hold up as had been the case in May. The ships Engineers tell me that on blackout the UPS throws the inverter input from the ships mains to the battery bank but approximately 30 seconds after the blackout that the battery isolation breaker trips as the batteries cannot hold the load on the inverter. This should all be checked out again when the batteries are replaced during the 1 month port period in Brisbane at the end of Fr06.

## Alpkem 510 Nutrient Detectors

Two Nutrient Detectors used by the chemists had problems during this leg.

One stopped working altogether. The lamp was not operational. This was traced to be no lamp ground being switched to the lamp filament. The cause of this was found to be some liquid which had managed to flow into the rear of the unit and get under a ribbon connector on the remote control PCB. This caused a 400 ohm leakage path between 2 pins on the connector which was sufficient to pull a normally logic high state down to a low. This flowed on through some logic circuitry and eventually preventing a transistor from switching the lamp ground.

All care should be taken to prevent chemicals spilling into electronic equipment.

The other Nutrient detector has an intermittent noise problem. All power supplies check out ok. Each time this unit was brought into the Electronics the fault seemed to disappear.

| Equipment/Systems | Used On Cruise | Required Attention During Cruise | Further Action Required | Action |
|---|---|---|---|---|
| Ctd Mkiiib #2 | | | | |
| Ctd Mkiiic #8 | | | | |
| Ctd Mkiiic #10 | | | | |
| Rosette Go 12bottle | | | | |
| Rosette Go 24 Bottle #1 | | | | |
| Rosette Go 24 Bottle #2 | | | | |
| Eg&G 1401 Deck Unit #1 | | | | |
| Eg&G 1401 Deck Unit #2 | | | | |
| Rosette Frame 12 Bottle | | | | |
| Rosette Frame 24 Bottle 2.5l | | | | |
| Rosette Frame 24 Bottle 10l | | | | |
| Seabird Frame 24 X 2.5 Litre | | | | |
| Seabird Frame 24 X 10 Litre | X | | | |
| Altimeter #162 | | | | |
| Altimeter #163 | X | | | |
| Pinger #1190 | | | | |
| Pinger #1266 | | | | |
| Seabird Ctd #19 | | | | |
| Seabird Ctd #20 | X | X | | |
| Ctd Sliprings/Cable | X | | | |
| Fluorometer Seatech 142s | | | | |
| Chelsea Transmissometer | | | | |
| Seatech Transmissometer | | | | |
| Licor U/W Light Sensors | | | | |
| Adcp | X | | | |
| Moon Pool Trolley | X | | | |
| Ea500 | X | X | | |
| Ashtech 3d Gps | X | X | | |
| Ashtech G12 Gps | X | | | |
| Fugro Dgps Receiver | | | | |
| Winch Monitoring System | X | X | | |
| Vaisala Balloon Receiver | | | | |
| Vaisala Data Converter | | | | |
| Met Station | X | | | |
| Synchro/Digital Converter | X | X | | |
| Doppler Log Interface | X | | | |
| Pa System | X | | | |
| Seabird Tsg | X | | | |
| Fluorometer (Wetlabs) | X | X | | |
| Ez Net | | | | |
| Datataker Gp Lab | | | | |
| Datataker Spare Elec W/Shp) | | | | |
| Scintillation Counter | | | | |
| Radiation Monitor | | | | |
| Westinghouse Mobilsat | | | | |
| Ctd Display Pc (Big Ctd) | X | | | |

| **Equipment/Systems** | **Used On Cruise** | **Required Attention During Cruise** | **Further Action Required** | **Action** |
|---|---|---|---|---|
| Xbt Display Pc | | | | |
| Ctd Display Pc | X | | | |
| Op's Room Pc (Pc-1) | X | | | |
| Op's Room Pc (Pc-4) | X | | | |
| Winch Control Area Pc | X | | | |
| Winch Display Pc | X | | | |
| Electronics Workshop Pc | X | | | |
| Critec Ups (Computer Room) | X | X | X | |
| Fdcs-Log-1 | X | | | |
| Fdcs-Log-2 | X | | | |
| Fdcs-User | X | | | |
| Xwindows Monitors | X | | | |
| Delp Monitors | X | | | |
| Video Camera System | X | | | |

# Appendix B – Computing Report for Franklin Voyage Fr05B/2001

*(Bob Beattie)*

# 1. Work Done

## 1.1 System management

1. Lindsay Pender complained of very slow network traffic to fdcs-log-1 during the latter part of 5A. Communications eventually failed completely. Re-seating fdcs-log-1's UTP connector seemed to fix the problem. e.g., I was able to transfer a 31.5Mb file between fdcs-log-1 & fdcs-user in under 44 secs (approx. 700 Kb/s).
2. The password on the Computer Room Remote Annex 2000 had been set to a non-standard value when the unit was replaced during Fr01/01. I reset the password to the 'normal' setting.
3. Email was used more heavily than ever. 2.18 Mb of messages were sent and 3.25 Mb were received for the 21 day leg, which translates to approx. 260 Kb/day.

   The email system played an important part in the research. e.g. the CFC team were in regular contact with their colleagues in the US, both to supply them with data updates or to seek assistance with solving the several instrumental and sampling problems that they encountered during the voyage

   On two occasions, the NEXUS password server in Hobart failed over a weekend and I had to phone Al Blake to ask him to restart it. We are indebted to him for his efforts.
4. INMARSAT B

   When making email transfers, I usually tried to make at least one attempt with the 'B', before I switched to the Mini M. Of the 91 attempts that I logged, 38 succeeded, 27 failed to connect because the line was reputedly 'BUSY' and on 26 occasions it dropped out after the connection was established.

   I could see no obvious pattern to the failures, except on one occasion, when it dropped out 3 times while the vessel was turning slowly to come onto station. The success rate did seem to improve in the last week of the voyage.

   In contrast to the 'B', the 'M' behaved almost flawlessly, with only one or two drop-outs for the entire voyage.

## 1.2 Data acquisition and acquisition software

1. The way program now handles way-points in the Western hemisphere. DELP now displays Western hemisphere positions correctly.
2. There was no provision for monitoring VOY-LOG or WLOG on DELP. These now publish data on sms and were added to the DELP options file.

3. Data backups are taking an increasingly long time. It took 5.25 hrs to do the final, 14Gb /data backup of fdcs-log-2 and even longer on fdcs-log-1, which was slowed down by the data collection system.

   I adopted a different strategy this voyage to try to spped things up. The /data backups were (meant to be) made well ahead of time and any new files were picked up in a final daily_cpio.

   We will have to re-think our backup strategies. I tried using tar, intead of cpio, in the hope of being able to achieve higher blocking factors, to reduce tape usage, but it seemed to store about the same amount of data as a cpio backup & could not handle continuation tapes.

   The backup scripts now return the time of completion, so we know how long they took.

4. Early in the voyage, we engaged in email correspondence with Jeff Dunn & Bernie re the quality of the ADCP data. Jeff suspected that the pitch & roll corrections were being applied incorrectly. We did not pursue the matter any further, as we presume that Jeff will be investigating the problem.

## 1.3 CTD data collection and processing

This took up a large part of my time during the voyage

1. There were two failures of the secondary Seabird conductivity sensors during the voyage. On both occasions, the failures were detected using procCTD plots. The replacement sensor has been very reliable, tracking to within 0.0011 - 0.0021 S/m of the primary sensor for the remainder of the voyage.

   The calibration of the secondary conductivity sensor was modified in the readCrw configuration file each time the sensor was changed. (It would be useful if the configuration editor had a ‘cut and paste’ facility to copy a calibration from one configuration file to another.)

2. Gary Carol’s CTD notes were converted to Frame & updated to reflect our current procedures.
3. The procCTD manual was updated.
4. Several minor modifications were made to procCTD
   - The ‘head-room’ in procCTDGetBurstData was increased from 2 to 6 minutes after it complained that there was no data for 10 of the 24 bottles on a deep test station. (The CTD had ‘drifted’ deeper after sampling had started, putting the missing samples in the downcast.)
   - procCTDApplyCondCal now gives the correct indication of ‘deployment progress’

## 1.4 Analysis & display software

I spent some time debugging & developing Gary Carol’s CTD sectioning and profiling programs. Further work needs to be done. There are still a few bugs and a GUI user interface would be useful. I almost completed one for the profiling programs, but I didn’t have time to adapt Lindsay’s deployment selection GUI.

John Church found the programs to be very useful for monitoring data quality, especially for highlighting problems with the hydro data. The rapid feedback meant that the problems could be rectified when things

were fresh in peoples' minds. It is very difficult to remember what was done when you are trying to rectify a problem several months down the track.

### 1.5 Miscellaneous

Mark Rosenberg, Lindsay Macdonald & I carried out tests with the new CSIRO xbt system, in response to a request from Lindsay Pender & Alex Papij. The results were emailed to Hobart.

## 2. Problems & recommendations

1. Several procCTD suggestions & problems have already been communicated to Lindsay by email and are not dealt with here.
2. procCTD's automated bad data detection does not reject steps in the conductivity due to cell contamination. This would best be done using an interactive, graphical procedure.
3. fdcs-log-1's console went blank early in the voyage, but the computer continued to run OK, so I did nothing about it until a power failure forced a reboot. The screen still didn't come up until I re- seated the keyboard cable.
4. fdcs-user experienced problems twice, one of them requiring a reboot. It is suspected that /tmp filled up due to the large number of plots being spooled from the pc's. We need a mechanism for periodically flushing /tmp or for deleting the print files after the jobs have completed.
5. The DELP nav output is periodically being corrupted. I suspect that this is due to a process overwriting the GPO sms latitude & longitude.
6. The Ashtec 3DF continues to hang periodically and has to be restarted, either by power cycling or by stopping and starting the logging software several times until it acknowledges the RESET command sent by the logging software. This has to be a firmware problem, and we should continue to make representations to Ashtec until it is solved.
7. The ADCP software hangs periodically - it seems to happen when 3DF data has been unavailable for some time. The ADCP logging & display processes have to be killed and restarted, usually twice, before logging will resume.
8. The Doppler Log logging controller reported bad data on a number of occasions. I did not have sufficient free time to investigate this further.

| Date | Contact | Data | Action | Summary |
|---|---|---|---|---|
| 2004-10-29 | Kozy | CO2 | DQE Begun | |

I have a file with all hydrographic, CFCs and Carbon data from P15S section from Australian scientists. I have put SR3 sign for this section instead and could not understand why I cannot find P15S. I have also a cruise report. Do you have all hydrographic data for this section and non of the carbon-related and CFC measurements?
I will make all necessary QA-QC work as usual and reformat these data to WHPO format and send the file to Steve.

| Date | Contact | Data | Action | Summary |
|---|---|---|---|---|
| 2004-12-10 | Kozyr | CFCs | Submitted | exchange file, includes all parameters |

I received the hydrographic and CO2 measurements from Susan E. Wijffels(CSIRO), made all QA-QC and sent the data to CCHDO on 12/10/2004.

From: KOZYR, ALEX
Email address: kozyra@ornl.gov
Institution: CDIAC/ORNL
Country: USA

The file:
fr0501_woce_exchange_cfc.txt - 827435 bytes
has been saved as:
20041210.131553_KOZYR_P15S_SR03_fr0501_woce_exchange_cfc.txt
in the directory:
20041210.131553_KOZYR_P15S_SR03
The data disposition is:
Public
The bottle file has the following parameters:
SALNTY, SALNTY_FLAG_W, CTDOXY, CTDOXY_FLAG_W, OXYGEN, OXYGEN_FLAG_W, SILCAT, SILCAT_FLAG_W, NITRAT, NITRAT_FLAG_W, PHSPHT, PHSPHT_FLAG_W, CFC-11, CFC-11_FLAG_W, CFC-12, CFC-12_FLAG_W, CFC113, CFC113_FLAG_W, CCL4, CCL4_FLAG_W, TCARBN, TCARBN_FLAG_W, ALKALI, ALKALI_FLAG_W
The file format is:
WHP Exchange
The archive type is:
NONE - Individual File
The data type(s) is:
Bottle Data (hyd)
Documentation
The file contains these water sample identifiers:
Cast Number (CASTNO)
Station Number (STATNO)
Bottle Number (BTLNBR)
Sample Number (SAMPNO)

KOZYR, ALEX would like the following action(s) taken on the data:
Place Data Online

Any additional notes are:
This is an exchange formatted file I received from John Bullister with all data parameters measured during the Deep-Ocean Time-Series Sections (DOTSS), Repeat Section P15S/SR03. I've made all QA-QC on carbon-related measurements (TCARBN and TALK). I also include a cruise report file for your information.

| Date | Contact | Data | Action | Summary |
|---|---|---|---|---|
| 2004-12-10 | Kozyr | TCARBN/ALK | Submitted | along w/ data report |
| | I have just submitted an exchange formatted file I received from John Bullister with all data parameters measured during the Deep-Ocean Time-Series Sections (DOTSS), Repeat Section P15S/SR03. I've made all QA-QC on carbon-related measurements (TCARBN and TALK). There is only one file I could submit at once using your web page, so I attached here a documentation file for P15S/SR03 cruise. | | | |
| 2004-12-13 | Anderson | CO2 | Submitted | Exchange file; to be put online |
| | Copied files submitted by A. Kozyr from INCOMING to .../p15s_2001a/original/20041210_KOZYR_P15S_2001.<br><br>Bullister gave this file to Kozyr. It is in exchange format and contains all data parameters measured duringDeep-Ocean Time-Series Sections (DOTSS).<br><br>These data need to be put online. | | | |
| 2005-01-04 | Key | CO2 | DQE Begun | will provide per S. Wijffels' OK |
| | Kozyr and I are currently working on a SR03, 2001, Franklin cruise. The files include CFCs and carbon as well as the routine stuff. I've contacted Susan Wijffels to try to clean up a few questions on flag values for the routine measurements and to make sure iit is OK to submit the results to you. | | | |
| 2005-01-04 | Key | BTL | DQE Begun | will submit per S. Wijffels' OK |
| | Kozyr and I are currently working on a SR03, 2001, Franklin cruise. The files include CFCs and carbon as well as the routine stuff. I've contacted Susan Wijffels to try to clean up a few questions on flag values for the routine measurements and to make sure iit is OK to submit the results to you. | | | |
| 2007-01-10 | Wijffels | BTL | Data Update | Date correction |
| | The date should be> 2000 9 27 23 53 15<br><br>That is 2000-09-27 @ 23:53GMT - add 12 hours to your date! I've attached the julian/gregorian .m files we use. The other values look correct.<br><br>I've attached ascii versions of the hydrology data which should be pretty easy to figure out for checking date and location translations.<br><br>I've also attached pdf's of the hydrology data processing. Please add a caveat if possible, that the nutrient data are suspect on both cruises - bottle salts and oxygens are good.<br><br>I'll send the CTD data processing reports along in another email. | | | |
| 2007-01-10 | Wijffels | Cruise Report | Submitted | CTD processing report |

| Date | Contact | Data | Action | Summary |
|---|---|---|---|---|
| 2007-04-10 | Key | BTL | Submitted | |

Metadata to accompany data submission of today. The version of the data I started with originated with Alex Kozyr (12/22/04). Most flags in that file were "1". I did primary QC on all parameters. Some notes included in the README file attached. Bottom depths estimated from global topography. All calculated parameters with my functions (depth, theta, sigmax, aou). I have not tried to get H3/He3 data from Lupton. Permission received from all PIs to submit/post. I will notify them that I submitted to you and to CDIAC. All units and flags WOCE standard. Place Data Online

1/25/05 Initialized README file for Franklin re-occupation of P15S
S. Wijffels Ch. Sci.
EXPOCODE: 09FA200105_1
leg 1: 5/24/2001 Dpt Wellington, NZ
6/16/2001 Arr. Tonga
leg 2: 6/16/2001 Dpt Tonga
7/7/2001 Arr Apia, Western Samoa
24bottle X 10 liter rosette
Splus name p15s2001a

Hydro: Who - Wijffels; Status - final; S Plus - up to date
Notes: File from Kozyr 12/22/04
Bottom depths estimated, bottle depths calculated
Flagged Salt: 76-1-14
See Johnson et al. 2007; Roemmich et al. 2007.

Nuts/O2: Who - ; Status - final(?); S Plus - up to date
Notes:
Deep nitrates are about 1umol/kg lower than NOAA 1996 occupation
Flagged NO3: 5-1-19,31-1-10,103-1-17,107-1-23,122-1-15
Deep phosphates are about .05 umol/kg lower than NOAA occupation
Flagged PO4: 1-1-24,5-1-19,96-1-20,103-1-17,109-1-8
Deep silicates are very similar to the NOAA occupation
Flagged Si: 5-1-9,53-1-5,64-1-1
Deep aou are very similar to the NOAA occupation
Flagged O2: 8-1-10,40-1-11,58-1-18,64-1-1,78-1-16,107-1-23
Note from Wijffels 4/10/07 - nuts still need more QC.

TCO2: Who - B. Tilbrook and C. Sabine; Status - final; S Plus - up to date
Notes: Batch 52 CRM
Shipboard value for 66 samples 2005.45+/-0.83
Deep tco2 are very similar to the NOAA 1996 occupation
Flagged: 10106 14105 24113 53105 78116 78115 107123 111101
113121 113110 115119 115107 128119

TA: Who - B. Tilbrook and C. Sabine; Status - final; S Plus - up to date
Notes: Batch 52 CRM
Shipboard value for 37 samples 2224.72+/- 1.03
Deep alk are very similar to the NOAA occupation
Flagged: 8108 10114 11115 12110 14107 14105 20107 28110 30103
37120 53105 58124 81124 91105 99104 106119 113110 116103

fCO2: Who - f; Status - not sampled; S Plus -

Notes:

pH25: Who - ; Status - not sampled; S Plus -
Notes:

CFC: Who - M. Warner and J. Bullister; Status - final; S Plus - up to date
Notes: full cfc-11&12 with partial CCl4

C-14: Who - ; Status - not sampled; S Plus -
Notes:

C-13: Who - ; Status - not sampled; S Plus -
Notes:

H-3/He-3: Who - J. Lupton; Status - no data yet ; S Plus -
Notes:

Other:
References:

Johnson, G. C., S. Mecking, B. M. Sloyan, and S. E. Wijffels. 2007. Recent bottom water warming in the Pacific Ocean. Journal of Climate, accepted.

Roemmich, D., J. Gilson, R. Davis, P. Sutton, S. Wijffels and S. Riser, 2006. Decadal Spin-up of the South Pacific Subtropical Gyre. J. Phys. Oceanogr., in press

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|---|---|---|---|---|
| 2008-12-04 | Key | BTL | Submitted | NUTs data reprocessed |

Introduction;
Data were collected in the Southern Pacific Ocean along P15S during 2001. The nutrient data from the voyage was known to have large errors associated with it, particularly with nitrate and phosphate. The data has been reviewed and re-processed, comparing it to the DISCO 1996 voyage along the same section. This report discusses the reprocessing method and results. All final results are reported in umol/kg. Nitrate concentrations refer to nitrate+nitrite.

Procedure:
1. Re-calculate concentrations: From about run 40 to near the end of the voyage, it was clear there was an issue with the Alpkem in both the nitrate and phosphate channels. It was discovered at the end of the voyage that there was a growth in both flow cells. This resulted in depressed peak heights (see figures below – ‘first set/second set’ refers to the first and second set of calibrants in each run). The re-calibration method uses the f values for each level of calibrant, and the sample results were calculated based on the f values from the next-highest calibrant.
2. Final plots to flag outliers: The final results were plotted against ctd pressure and theta to identify outliers. The outliers were flagged as ‘bad’ (with a 4 according to WOCE standards). Any results where pressure was missing were flagged with a 4 and any where oxygen and salinity were missing were flagged with a 3 (questionable).

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|---|---|---|---|---|
| 2008-12-16 | Key | BTL | Submitted | NUTs/CO2/ALK/CFCs/He |

Status: public
Action: Place Online

You will get another copy of this file when I submit the CARINA tarball. I seriously doubt there will be any differences. If there are, it will be reflected in the datestamp within the datafile.

| Date | Contact | Data | Action | Summary |
|---|---|---|---|---|
| 2009-08-18 | Kappa | Cruise Report | Website Updated | New TXT report online |
| | New cruise report inludes:<br>1) Original cruise report submitted by PI<br>2) Data reports available at CSIRO website:<br>http://www.marine.csiro.au/marlin/rvdata1.htm<br>3) Data processing notes | | | |
| 2009-08-18 | Kappa | Cruise Report | Website Updated | Nutrients report added |
| | New cruise reports, both text and pdf versions, now contain a report on Nutrient data processing, and are online. | | | |